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authors: carolyn arena, deborah collins, john gawalt,
and melissa pollak

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Contributors

Data collection, preparation, and tabulation were performed by the Bureau of the Census, Department of Commerce, for the National Science Foundation. Principal authors of this report were Carolyn Arena, Deborah Collins, John Gawalt, and Melissa Pollak. Others who contributed to the production of the report are Millicent V. Gough, editor; Elizabeth J. Michael, editorial assistant; and Julia Harriston, word processor.

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general notes

The Bureau of the Census (Census), Department of Commerce, has conducted the annual Survey of Industrial Research and Development for the National Science Foundation (NSF) since 1957. This report provides data on research and development (R&D) funding for the years 1978-88 and on R&D personnel for the period from January 1979 to January 1989.

All companies—foreign and domestic as well as those privately held—that perform R&D in the United States are included or represented in the survey data.

The industry R&D survey does not cover trade associations. Although their primary mission is to serve industry, these associations are established as nonprofit organizations, and it is estimated that their R&D expenditures are less than 1 percent of the industry R&D total.

It is an enterprise- rather than an establishment-based survey. Therefore all R&D data for each enterprise are reported in the major Standard Industrial Classification (SIC) code of the firm. Data are aggregated in this manner for all tables in this report.

Data are based on probability samples selected about every five years. In intervening years, a subset of the last sample, called a "panel," is used. The latest probability sample was selected and first used for survey year 1987.

Census staff conduct the survey under Title 13 of the U.S. Code, which prohibits publication or release of data that may reveal information about individual companies. Therefore, on some tables of this report, the symbol "(D)" is used as a footnote reference to indicate that data are being withheld to avoid possible disclosure of information about operations of individual companies.

Complete technical notes are contained in section A. Questions regarding the survey may be telephoned to John Gawalt, at (202) 634-4648, or mailed to him at the following address: National Science Foundation, Division of Science Resources Studies (L602), Washington, D. C. 20550.

section a

technical notes

introduction

The Survey of Research and Development in Industry provides national estimates of the total expenditures on R&D performed *within the United States* by industrial firms, whether U.S.- or foreign-owned. It is a sample survey in which it is intended that all R&D-performing companies, including privately-held firms, are included or represented. All companies that are identified in the sample year as annually spending more than $1 million on R&D in the United States receive a survey form every year. Information from individual companies in the sample is used to develop national estimates on an industry-by-industry basis.

NSF has been sponsoring a survey of industrial R&D since 1953. The 1988 Survey of Research and Development in Industry is the 32nd in the annual series sponsored by NSF and conducted since 1957 by Census. NSF's Division of Science Resources Studies monitors the survey. NSF also sponsored two industrial R&D surveys covering the 1953-56 period that were conducted by the Bureau of Labor Statistics (BLS), Department of Labor.[1] Data obtained in the earlier BLS surveys are not directly comparable with Census figures for 1957-88 because of methodological and other differences in the surveys.

Respondents receive detailed definitions to help them determine which expenses to include or exclude from the R&D data they provide. Nevertheless, the statistics presented in this report are subject to response and concept errors caused by different respondent interpretations of the definitions of R&D activities and by variations in company accounting procedures. Consequently, the data are better indicators of changes in, rather than absolute levels of, R&D spending and personnel. Data quality has improved substantially since the first industry R&D survey was undertaken, mainly because respondents have adopted more accurate and sophisticated accounting procedures over the years.

The survey's primary focus is on U.S. industry as a *performer* of, rather than as a *source* of funds for, R&D. Thus, data on Federal support of R&D activities performed by industry are collected and appear in several tables, but data on industrial funding of R&D undertaken at universities and colleges and other nonprofit organizations are not included in the major tables.[2]

The survey data provide (1) national estimates of total R&D performed by industry in the United States; (2) the portion of the effort that is financed by U.S. Government funds; and (3) the amount financed by the companies themselves or by other non-Federal sources such as state and local governments or other industrial firms (chart 1.) Also included are data on both the number of employees and the number of R&D-performing scientists and engineers at the firm, as well as on the domestic net sales for the company, and on the total funds for R&D financed by the domestic firm but performed outside the United States. A complete list of tables developed from the survey data is presented in section B, and copies of the 1988 survey form and other survey instruments are printed in section D.

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[1] National Science Foundation, *Science and Engineering in American Industry. Final Report on a 1953-54 Survey* (NSF 56-16) and *Science and Engineering in American Industry, 1956* (NSF 59-50) (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office, 1956 and 1960).

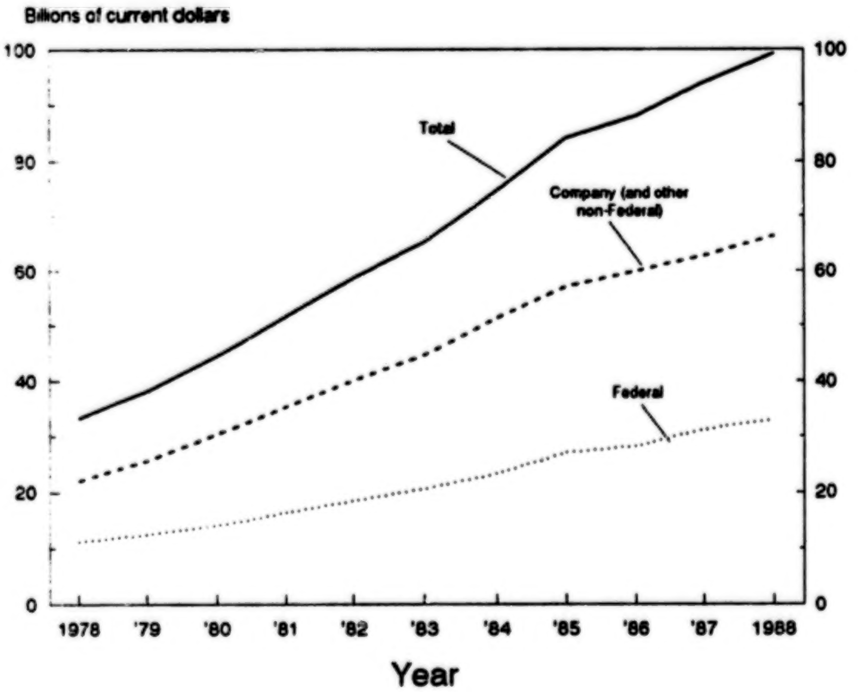
[2] Data on industry funding of R&D performed at universities and colleges are collected in the annual Survey of Scientific and Engineering Expenditures at Universities and Colleges. More information about this survey is available from the Universities and Colleges Studies Group of NSF's Division of Science Resources Studies, (202) 634-4673.

The scope of the survey has been expanded and refined over the years, in response to an increasing policy need for more detailed information on the Nation's R&D effort. For example, questions on energy R&D were added in the early seventies following the first oil-shortage crisis. On the other hand, the frequency of collection of certain data items has been reduced in an attempt to alleviate some of the respondent burden that has been placed on industry from all sources in recent years. The detailed questionnaire is now mailed only in odd-numbered years; abbreviated survey forms containing only the most crucial data elements are sent to respondents in the intervening, even-numbered years. Both long and short survey forms are called RD-1.

The shortened survey form was used for the first time to collect industrial R&D data for 1978. This report provides data collected from the short form that covers 1988 data.

Questions appearing only biennially on the long form request detail on such areas as the following: R&D by product field, company expenditures for R&D projects that were contracted to outside organizations rather than performed in-house, Federal R&D support to the firm by contracting agency, R&D expenditures by geographic area, and some detailed data on energy and pollution-abatement R&D activities

Chart 1. Industrial R&D performance by source of funds



SOURCE: National Science Foundation, SRS

methodology of survey[3]

overview

Data in this survey are based on a sample of industrial firms, selected approximately every five years (e.g., 1976, 1981, 1987). In intervening years only a subset of the sample, or "panel," receives annual survey forms (for a complete discussion see, **The Annual Panel**) and Census makes estimates for the changes in R&D for the firms not canvassed annually. The sampling unit for this survey is the enterprise, or company, defined as a business organization consisting of one or more establishments under common ownership or control. The 1988 data in this publication are based on responses from a panel derived from the sample selected and first used for survey year 1987. (The previous sample was selected for the 1981 survey and the panel was used in subsequent annual surveys until 1987.)

The sampling frame from which the sample was drawn includes companies in all manufacturing industries and, on the basis of earlier samples, a select number of nonmanufacturing industries known to conduct R&D.

The Standard Statistical Establishment List (SSEL), a Census compilation that contains information on 3.5 million to 4.0 million establishments, was the universe frame used to select the 1987 sampling frame. Where necessary for multiestablishment companies, Census summed establishment-level data to the company level, and then assigned a single SIC code[4] to that firm—the SIC code of the establishment(s) having the highest dollar-value of payroll.

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[3] The bulk of this section was prepared in the Industry Division of the Bureau of the Census, the collecting and compiling agent for the National Science Foundation.

[4] Executive Office of the President, Office of Management and Budget, *Standard Industrial Classification Manual, 1972* (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office).

The weight given to an individual company is in general the inverse of the probability that the company would have been selected for inclusion in the sample. Certainty companies (for a detailed discussion, see **Frame Creation**) have a weight of 1.00. The company weight is retained in both the sampling year and in the years between samples. To minimize respondent burden, only the "panel" subset of the sample is canvassed between sample years. Most small firms are not re-contacted, but in each succeeding year Census estimates the data for each non-canvassed firm, based on the changes in the initial value of the R&D reported by the firm, and the average growth rate for the firm's industry.

frame creation

In selecting a sample frame from which to draw a sample of R&D-performing industries, NSF staff make certain assumptions about industries to be able to maximize sampling efficiency given a finite budget for sample selection. That is, they apply *a priori* knowledge of industrial R&D activity to eliminate some industries from the possibility of selection by the initial SSEL sort and to designate other companies for sampling with 100 percent certainty. In addition, NSF staff made several innovations for the sample drawn in 1987 to improve its quality.

As in previous sample years, all companies that had been on the previous panel once again received a survey form. In addition, Census staff reviewed lists of R&D contractors published by the Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA) to ensure that all their large industrial R&D-performing contractors were included in the sample with certainty.

From the outset in the latest sample selection, the major goal was to eliminate from the sampling frame, to the greatest extent possible, companies unlikely to have R&D programs. This was done to minimize the number of companies chosen for the sample which had no R&D activity. To accomplish this objective, two steps were taken:

1. NSF staff narrowed the list of nonmanufacturing industries considered "in-scope," by eliminating those likely to engage in little or no R&D activity. Thus, companies in the eliminated nonmanufacturing industries had no chance of being selected. This gave companies in the manufacturing industries and the remaining nonmanufacturing industries a greater probability of selection than they had in past sample selections.

2. Companies below a certain employment size level—even in some "in-scope" industries—were eliminated from the universe frame. An assumption was made that companies with only a small number of employees in some industries are unlikely to engage in R&D activity. NSF staff provided an employment cutoff for each industry group. Generally the cutoff in the selected industries was 250 employees, but hospitals were given an employment cutoff of 1,000 employees. Those companies with smaller employment levels were eliminated from the frame.

Further, all companies with more than 500 employees in the "in-scope" industries, except for hospitals that had a cutoff of 1,000, were sampled with certainty.

In another effort to improve coverage of R&D-performing companies, NSF staff in 1987 provided to Census the names of firms, identified through media reports or other sources as R&D performers, that were to be included in the sample with certainty. Most of these companies would have received questionnaires anyway because they met other established criteria; the few that did not were added to the sample by Census.

All certainty companies—those on lists provided by NSF staff, on lists of DOD and NASA contractors, companies with more than 500 employees, and previous panel members—are self-representing, i.e., they have sampling weights of unity (1.00).

Based on (1) SIC code, (2) total employment cutoffs, (3) inclusion on an NSF, DOD, or NASA list, or (4) previous panel membership, approximately 154,000 companies were identified as "in-scope" of the survey and therefore were included in the sampling frame. The new efforts to improve targeted coverage resulted in a sharp reduction in the size of the total in-scope universe; it dropped from about 450,000 companies in the 1981 sampling frame to approximately 154,000 companies in the latest operation.

It is likely that a small number of companies actually engaged in R&D activity was omitted from the sampling frame as a result of these first-time sample selection operations. It was agreed, however, that the benefit from the new operations—greater sampling efficiency resulting in improved national estimates of industrial R&D expenditures and employment—far outweighed the cost of the loss of a few companies that may have been eliminated from the in-scope sampling frame.

probability proportionate to size

As with most types of economic surveys, the sample selection process for the industrial R&D survey used probabilities proportionate to size. That is, "large" companies have a proportionately higher probability of selection than do "small" companies, where large or small is measured relative to the statistic being estimated.

For the R&D survey, it would have been ideal if size could be determined by the amount of a company's R&D expenditures. Unfortunately, except for the companies that were in the current panel, it was impossible for Census to know the R&D expenditure values for firms in the universe frame. One logical solution was to estimate each company's R&D expenditures and base the probability of selection on the estimated values. The same strategy had been employed in the 1981 sampling operation.

Clearly, this strategy has weaknesses. Even with the reduced number of in-scope industries in the sampling frame, many companies chosen for the frame may not have engaged in any R&D activity. Nevertheless, the procedure used to estimate the size of companies, described in the following paragraph, was forced to treat all companies as if they did in fact, perform R&D:

Census estimated the size of each company's R&D expenditures by using a relationship linking the size of its employment to its amount of R&D expenditures. [Since company employment was known for the universe, it was possible to use this relationship to estimate R&D expenditures values for all companies in the frame. Census derived this relationship for each SIC classification category, using data collected in the then most recent (1985) R&D survey]. Rather than treating all companies equally, the larger the number of employees in a company, the higher the probability of selection for inclusion in the sample. It was deemed reasonable to assume that large companies were more likely to have R&D programs than small companies.

One further adjustment was introduced that had not been made in previous sample selections. This was based on the assumption that multi-establishment companies of a given size and in a given industry would on average be expected to perform more R&D than single-establishment companies of the same size and in the same industry. Once again, 1985 panel data were used to develop this adjustment factor. Finally, it should be noted that the actual reported R&D activity, not an imputed value, was used for companies which were in the previous panel, and the data were not adjusted.

sample allocation and relative standard error constraints

The sampling program utilized for this operation allowed parameters to be assigned permitting the sample to be allocated across various levels or strata that correspond to industry groupings. This procedure permitted a desired sample size or a desired sampling error to be achieved for each strata. Estimated errors of total R&D estimates for these strata were not to exceed certain levels. Since the amount of funds provided by NSF determined the size of the sample to be drawn, the only constraint in achieving these results was that the total sample size across all the strata could not exceed 12,000-13,000 companies. NSF staff provided relative rankings for each industry group—high, medium, or low—to determine the precision of the estimate. An actual translation to what high, medium, or low meant specifically could not be determined until Census staff arbitrarily investigated several sampling error levels, computed the sample size that these levels implied, and applied the constraint of the total sample size of 13,000. The result of this investigation led to the following criteria for the target sampling error of estimate of funds for R&D performance:

a. **High precision:** sampling error not to exceed 2 percent
b. **Medium precision:** sampling error not to exceed 5 percent
c. **Low precision:** sampling error not to exceed 10 percent

Based on the desired precision, these criteria suggested a total sample size of approximately 13,500. This number was not excessively beyond the stated limit of 13,000, so this was the sample size parameter chosen for the selection process.

One limitation should be noted. Sampling errors were controlled by using a universe total that in large part was improvised; that is, and as previously noted, Census assigned an R&D value to every company in the frame record, even though many companies in the sampling frame may not actually have had R&D expenditures. The value assigned was imputed for the great majority of companies in the frame, and, as a consequence, the estimated universe and the distribution of individual company values did not necessarily reflect reality. Estimates of sampling variability were nevertheless based on this distribution. The presumption was—and this had been confirmed in the previous sample selection—that actual variation in the sample design would be less than that estimated because so many of the sampled companies have true R&D values of zero, not the widely varying values that were imputed using total employment as a predictor of R&D. Thus, the 2 percent, 5 percent, and 10 percent error levels described earlier are conservative. [See table A-1 for a complete list of the actual standard errors in the 1988 survey.]

The particular sample selected is one of a large number of the same type and size that, by chance, might have been selected. Estimates from each of the different samples would differ somewhat from each other and from the results of a complete canvass conducted under essentially the same conditions as the survey.

In addition to sampling error, the estimates are subject to nonsampling error that would also occur if a complete canvass were to be conducted under the same conditions.

sample selection

The sample selection program was run with a specified sample size (expected) of 13,500 and with other parameters set to ensure compliance with the relative standard error constraints. An actual sample of 13,917 was selected. The actual sample size differs from the specified for two reasons:

First, the program used independent sampling. Each company had an independent chance of selection based on

Table A-1. Standard error of estimate (percentage) of funds for R&D performance for all company size-groups and for companies with fewer than 1,000 employees by industry: 1988

Industry	SIC code	Standard error(1)	Standard error of companies with fewer than 1,000 employees
Total	....	0.6	6.6
Food, kindred, and tobacco products	20,21	0.0	0.0
Textiles and apparel	22,23	7.9	43.8
Lumber, wood products, and furniture	24,25	0.5	6.7
Paper and allied products	26	3.7	40.7
Chemicals and allied products	28	2.7	39.8
Industrial chemicals	281-82,286	0.4	23.1
Drugs and medicines	283	0.7	29.7
Other chemicals	284-85,287-89	13.8	51.4
Petroleum refining and extraction	13,29	0.2	24.6
Rubber products	30	1.8	22.5
Stone, clay, and glass products	32	0.7	23.9
Primary metals	33	1.3	25.0
Ferrous metals and products	331-32,3398-99	3.1	54.0
Nonferrous metals and products	333-36	0.5	10.6
Fabricated metal products	34	13.9	43.8
Machinery	35	2.3	18.3
Office, computing, and accounting machines	357	2.1	31.8
Other machinery, except electrical	351-56,358-59	7.4	21.4
Electrical equipment	36	1.8	17.1
Radio and TV receiving equipment	365	4.7	25.6
Communication equipment	366	2.2	45.8
Electronic components	367	3.7	20.2
Other electrical equipment	361-64,369	2.8	11.1
Transportation equipment	37	0.1	27.8
Motor vehicles and motor vehicles equipment	371	0.4	69.9
Other transportation equipment	373-75,379	1.3	26.8
Aircraft and missiles	372,376	0.0	0.0
Professional and scientific instruments	38	1.1	8.5
Scientific and mechanical measuring instruments	381-82	2.1	9.6
Optical, surgical, photographic, and other instruments	383-87	1.2	14.6
Other manufacturing industries	27,31,39	1.7	14.3
Nonmanufacturing industries	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	3.2	7.6

(1) A description of the standard error of estimate is given in section A under "Methodology of Survey." The percentage (or relative) standard errors in this table may be converted to standard errors of estimate by multiplying the percentages shown by the associated estimates. For example, the relative standard error of estimate for R&D performance for all company size-groups in the chemicals industry (SIC 28) is shown as 2.7 percent, and the associated total R&D estimate for this industry is shown as $10,774 million in table B-3, "Total (company and Federal) funds for industrial R&D performance by industry and size of company: selected years." The standard error of estimate, then, is .027 times 10,774 or 290.9.

SOURCES: U.S. Department of Commerce, Bureau of the Census its assigned probability; the selection, or nonselection, of a company was completely independent of the selection of any other company.

In independent sampling, sample size is itself a random variable. Theoretically, a sample of size 0 or a sample the size of the entire universe is possible, but the probabilities of these extremes are so small that these are nearly impossible situations. The actual sample size is usually quite close to the specified size. If there is too much deviation, the program is simply executed again.

Second, a minimum probability rule was imposed. As noted earlier, the sampling program assigns probabilities proportionate to size (where size in this case is the imputed R&D value assigned each company). Selected companies that have R&D programs vastly larger than their assigned values can have adverse effects on the estimates once the data are collected. To lessen these effects, the maximum weight a company can assume was arbitrarily controlled by specifying that the probability of selection cannot be less than a certain value. If the probability based on its size is less than this minimum value, then it is set equal to this value. The consequence of raising these original probabilities to the minimum probability is to raise the expected sample size. It is likely that most of the difference between the specified sample size and the actual sample size is due to this rule.

the annual panel

The panel is a group of companies that receive a survey questionnaire, form RD-1, annually. The following is a description of how the present panel was formed from the new sample in 1987:

The basic tool for the survey is form RD-1, which is used to collect detailed R&D information. Companies that were in the old panel and had received a 1986 RD-1 form (1,095 companies) once again received an RD-1 form for 1987. The remaining certainty companies (6,903) and noncertainty companies (5,919) in the new sample received an RD-1A survey form for 1987. Form RD-1A is an abbreviated version of RD-1 and is generally mailed to companies only in the year in which a new sample is drawn. The purpose is to canvass smaller R&D performers, while imposing a minimum of reporting burden on them.

Of the 13,917 companies that received a form in 1987, 3,648 respondents reported that their companies were R&D performers, or were identified as R&D performers based on information from other sources. The 3,648 companies were ranked by total R&D funds (both companies' own and Federal) within each SIC code. All companies with over $1 million in total R&D expenditures were placed on the RD-1 panel. In addition, in some industries Census added to the panel companies with less than $1 million in R&D expenditures, in an attempt to ensure 95 percent coverage of the R&D total for each industry.

The result of this process was an increase of panel size from 1,095 companies based on the previous sample to 1,742 companies based on the sample drawn in 1987. All companies selected for the panel will receive the RD-1 questionnaire annually until the next sample is drawn. The other companies will not receive another questionnaire; their R&D data will be estimated in subsequent years by Census staff, using their 1987 reports as a base.

timing of the 1988 survey

The survey questionnaires were mailed in January 1989, and nonrespondents received followup letters and telephone calls. Even when forms are received, however, there are often problems with item nonresponse. Many firms choose to send back the survey forms with one or more items blank, for varying reasons—for instance, the internal accounting procedures of the firm may not allow it to quantify R&D by, say, pollution-abatement expenditures.

In addition, some firms as a matter of policy refuse to answer any voluntary questionnaires. Four data items on the RD-1 questionnaire (total R&D expenditures, Federal R&D funds, net sales, and employment), however, are in fact included in Census' mandatory statistical program. Therefore the few companies that had not returned form RD-1 for 1988 were mailed MA-121 forms, which are questionnaires used to collect only the items for which replies are mandatory. The response rate for these mandatory items was obviously better than for the other questions on the survey.

When respondents do not provide the requested information, Census estimates the missing data for each firm by using the current average change for that firm's industry applied to a base of data provided by the company in earlier years. This procedure is also used to estimate the R&D of non-panel firms—i.e., firms that are in the sample and receive an RD-1A form in the sample year, but which because of size are not surveyed again until the next sample.

Table A-2 contains imputation rates for the principal survey items. For a detailed discussion of the problems stemming from item nonresponse, see the companion Technical Report, *Estimating Basic and Applied Research and Development in Industry: A Preliminary Review of Survey Procedures*, in press.

comparability of data over a period of several years

Several procedures are undertaken to revise data and maintain the reliability of the time series data of industial R&D:

Table A-2. Imputation rates for selected R&D survey items by industry: 1988

[Percent]

Industry	SIC code	Net sales	Employment	Scientists/ engineers	Total R&D funds	Company R&D funds	Federal R&D funds	Energy R&D	Pollution abatement R&D	Foreign R&D
Total		20.2	28.6	43.1	10.1	13.1	9.4	30.7	59.3	9.9
Food, kindred, and tobacco products	20,21	26.3	27.0	65.1	30.6	30.6	0.0	0.0	17.3	29.0
Textiles and apparel	22,23	54.8	59.3	71.1	40.8	43.5	0.0	0.0	71.5	0.0
Lumber, wood products, and furniture	24,25	31.0	36.1	64.1	16.0	16.1	0.0	4.0	0.0	0.0
Paper and allied products	26	22.6	27.4	58.4	14.5	14.9	0.0	26.7	11.0	0.0
Chemicals and allied products	28	7.5	13.0	49.4	5.3	9.6	0.5	59.8	29.2	26.6
Industrial chemicals	281-82,286	1.6	2.0	55.9	0.6	0.7	0.0	63.9	29.8	47.8
Drugs and medicines	283	9.6	9.7	41.3	5.4	14.4	7.4	0.2	4.5	0.0
Other chemicals	284-85,287-89	14.5	30.3	55.7	14.2	15.0	-	1.4	34.4	0.0
Petroleum refining and extraction	13,29	5.1	6.6	31.5	0.9	25.2	0.0	26.9	0.0	0.0
Rubber products	30	28.5	52.4	75.9	10.5	10.6	6.7	0.0	71.0	0.0
Stone, clay, and glass products	32	22.9	23.3	20.6	3.0	6.4	2.3	0.0	0.0	0.0
Primary metals	33	23.4	31.1	47.0	13.7	14.1	4.8	0.0	0.4	0.0
Ferrous metals and products	331-32,3398-99	28.9	38.0	66.3	27.8	27.8	19.5	0.0	1.5	0.0
Nonferrous metals and products	333-36	15.4	20.8	33.3	4.0	3.9	4.0	0.0	0.0	0.0
Fabricated metal products	34	43.7	46.4	60.2	30.6	36.0	0.5	93.9	98.6	0.0
Machinery	35	20.4	23.1	24.3	9.5	15.5	1.1	3.4	1.5	1.0
Office, computing, and accounting machines	357	9.4	8.8	15.9	6.7	14.2	0.1	8.5	-	1.0
Other machinery, except electrical	351-56,358-59	28.7	34.6	51.9	20.2	20.1	30.1	3.1	1.5	0.0
Electrical equipment	36	13.8	15.5	47.2	9.1	11.3	5.7	19.9	0.0	18.9
Radio and TV receiving equipment	365	34.3	40.0	34.0	17.9	17.9	-	-	-	0.0
Communication equipment	366	4.7	5.3	32.9	5.1	4.6	6.2	0.0	0.0	0.0
Electronic components	367	22.8	23.7	61.3	15.3	18.0	3.0	91.2	-	46.9
Other electrical equipment	361-64,369	22.7	26.9	77.0	17.7	20.0	13.6	3.2	0.0	0.0
Transportation equipment	37	7.9	9.2	31.3	8.1	5.7	9.6	44.2	75.1	0.4
Motor vehicles and motor vehicles equipment	371	4.4	5.8	37.4	0.6	0.8	0.0	95.2	85.1	0.0
Other transportation equipment	373-75,379	39.3	44.3	85.8	25.2	34.4	0.0	0.0	0.0	0.0
Aircraft and missiles	372,376	10.0	8.8	27.4	10.7	10.3	10.8	13.4	8.9	2.5

See footnotes at end of

Table A-2. Imputation rates for selected R&D survey items by industry: 1988 (continued)

[Percent]

Industry	SIC code	Net sales	Employment	Scientists/ engineers	Total R&D funds	Company R&D funds	Federal R&D funds	Energy R&D	Pollution abatement R&D	Foreign R&D
Professional and scientific instruments..	38	12.1	17.8	63.9	7.2	9.7	6.2	0.0	0.0	6.4
Scientific and mechanical measuring instruments............................	381-82	20.6	29.2	77.4	10.9	17.6	50.6	0.0	0.0	0.0
Optical, surgical, photographic, and other instruments.....................	383-87	8.8	11.7	52.6	5.6	6.1	0.5	0.0	0.0	7.0
Other manufacturing industries...........	21,27,31,39	27.7	32.9	73.2	18.5	19.8	0.0	-	0.0	9.0
Nonmanufacturing industries..............	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	33.4	49.5	54.7	25.0	27.5	19.0	33.1	47.5	0.0

- Represents no basis for imputation.

SOURCE: U.S. Department of Commerce, Bureau of the Census

two-year comparability

Before the survey forms are mailed each year, Census imprints on each questionnaire the data reported by the respondent the previous year (or two years earlier for items asked only in odd-numbered years.) Respondents are asked to adjust data for the previous year(s) if necessary to make them comparable to data provided for the current year. Such adjustments are necessitated by any of several developments, e.g., changes in company structure such as mergers, acquisitions, or divestitures; changes in reporting concepts; and even correction of any errors that may have been made previously. Thus, there is comparability in the reporting of survey data over any 2-year period. To maintain consistency of published data, Census adjusts the employment-size classification of any company affected by such changes so that the company is tabulated in the same employment-size category for two consecutive years.

These adjustments can be examined by comparing data for the same year reported in two succeeding periods, e.g., 1987 data appearing in the 1987 edition of *Research and Development in Industry* may differ from 1987 data in this volume. Totals for broad classifications are likely to be very close in the two editions; differences are more noticeable in the finer detail. These differences underscore the point that the measures are approximate and indicative rather than precise.

historical data revisions

The published industry R&D survey data are revised periodically, usually because of changes in the SIC code classifications of companies. In addition, two other major data revisions were made in the data for the 1981-87 periods. All of the revisions are explained as follows:

Companies may shift from one SIC code into another because of any of the following: (1) The growth and/or decline of product lines, (2) the merger of two or more companies, (3) the acquisition of one company by another, (4) divestiture, or (5) the formation of conglomerates. When Census staff are aware of the year in which changes #2, #3, #4, or #5 occurred [respondents are asked on the questionnaire about changes in ownership], they reclassify that firm's data into the new industry for the year the change actually occurred. If a change was not discovered until the new sample was selected or if it could not be determined when a shift actually occurred (i.e., #1), other methodologies were used to adjust, or "backcast," the data to reflect the move of a company out of one industry and into another. Since 1967, three revisions were made in the data, covering the periods 1967-76, 1976-81, and 1981-87

1. The 1967-76 Period

The SIC codes assigned to companies in the panel for the years 1967 through 1975 were based on data reported in the 1967 economic census. The 1974 SSEL file was used to assign SIC codes to companies in the next panel chosen for the 1976 survey. These codes were used to revise 1975 data received in the 1976 survey. The SIC codes of companies in the 1967 and 1976 panels were examined to determine which companies had changed classifications. Since it was not known in which year changes actually occurred, data of companies that had changed SIC codes were revised for the years 1968 through 1974 to smooth the changes over the period 1967-76. To illustrate, if a company was originally in SIC A in 1967 but was discovered to be in SIC B in 1974, its data for 1967-74 were allocated between the two industries as follows: 1967—all of the company's data were retained in industry A; 1968—14.3 percent of the company's data was allocated to industry B, and the remainder retained in industry A; 1969—28.6 percent was allocated to industry B, and the remainder retained in industry A; and so on until 1974, when all of the company's data were allocated to industry B.

2. The 1976-81 Period

"Backcasting" revisions in the industry R&D data for 1976-80 were also made to reflect the classification changes revealed in the new sample drawn in 1981; however, a different methodology was used for the revisions.

When the new panel was selected in 1981, companies were assigned SIC codes from the 1981 SSEL and the 1981 Enterprise Files. Prior-period (1980) data were collected in the 1981 survey. These data were presumed to be more accurate than those collected in the 1980 survey because they not only reflected updated SIC code classifications, but also were obtained from a larger panel providing better coverage of U.S. industry. Data obtained for 1976-80 using the panel selected in 1976 were revised subject to the following constraints:

a. Data for 1976, revised from the 1977 survey would remain unchanged since this was the first year the 1976 panel was used, and since that panel was an accurate reflection of company SIC codes in 1976.
b. Data for 1980 collected in the 1981 survey would be used instead of the 1980 data collected in the 1980 survey.

An algorithm was used to link data from 1976 with those collected in 1981, preserving, to the greatest extent possible, year-to-year trends in data for each industry by revising data for the years 1977, 1978, and 1979.

The following data elements were adjusted using the methodologies just described: Funds spent on R&D (total, Federal, and companies' own); number of FTE R&D scientists and engineers; total and company R&D

funds as a percent of net sales; and cost per R&D scientist or engineer. No adjustments were made in other data elements.

3. The 1981-86 Period

Similiar "backcasting" revisions in the industry R&D data were made in 1987 for the industry data previously reported for the years 1981-86. Several other adjustments were made in 1987 in addition to the original methodology described for the revisions made in 1981.

When the 1987 sample was selected, companies were assigned SIC codes from the 1987 SSEL File. Companies in the sample were asked to submit their prior-year (1986) data along with the information collected for the 1987 survey. These "new" 1986 data were used in lieu of the data originally collected in the 1986 survey because they reflected updated SIC code classifications of companies, and also were collected from a much larger sample that had been designed to provide better coverage of U.S. industry, particularly the nonmanufacturing portion. Data obtained for 1981-86 using the panel selected in 1981 were revised in 1987 subject to the following constraints:

a. Data for 1981, revised from the 1982 survey, would remain unchanged since this was the first year the 1981 panel was used, and since that panel was an accurate reflection of company SIC codes in that year.
b. Data for 1986 collected in the 1987 survey would be used instead of the 1986 data collected in the 1986 survey.

There was an increase of $9,265 million between the 1986 data based on the old panel, and the 1986 data reported by the new panel identified in 1987. Most of that aggregate revision was caused by the addition of new R&D performing firms identified through the improved sampling procedures in 1987. An algorithm was used to link data from 1981 with those collected in 1987, preserving to the greatest extent possible, year-to-year trends that had previously been reported in data for each industry by revising data for the years 1982, 1983, 1984, and 1985. Interested persons should contact Census to obtain further information about the construction and content of the algorithm.

4. Data Reevaluations for 1987

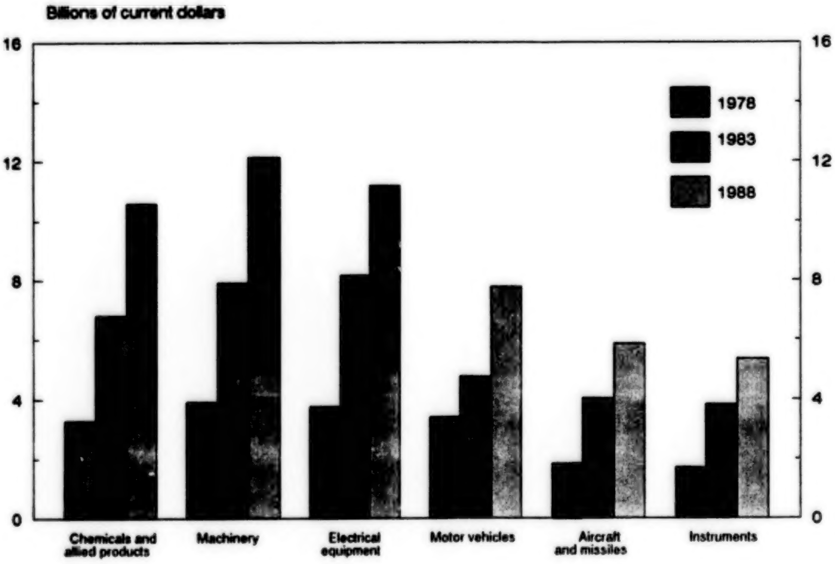
Aside from the "backcasting" adjustments made to previously published data based on new information discovered in the sample in 1987, there was also an additional adjustment made to 1987 data in 1988, based on revised information that was received with the 1988 forms: Many of the small firms identified in the enlarged sample in 1987 were receiving this kind of form for the first time, and a number of these firms were not accustomed to receiving questionaires that asked for answers rounded to the nearest thousand. Consequently, several firms were selected for the 1987 panel based on the size of their reported R&D program. These same firms realized their initial rounding error when they received the 1988 form with the imprinted prior-year data. The respondents made revisions to their 1987 data when they submitted the 1988 forms; these revisions resulted in an aggregate downward revision of the 1987 data of $1,717 million. These revisions are reflected in the current publication.

Based on all the adjustments listed above, chart 2 depicts trends in company R&D expenditures for individual industries:

5. Federal Data for 1986

There will be one additional revision to 1986 data that does not appear in this volume. Shortly before this document was published, NSF staff discovered that 1986 data on Federal R&D support for industry had been miscalculated. Data for a

Chart 2. Company and other (except Federal) funds for R&D performance by selected industry



SOURCE: National Science Foundation, SRS

merger between two companies had not been correctly processed, resulting in an overcount of $356 million. The 1986 industry R&D total (company, Federal, and other funds) should be $87,823 million instead of $88,179 million, and Federal total should be $27,891 million instead of $28,247 million. Revised 1986 data will be printed in the 1989 edition of this report. Published individual industry data will not change, because data for the affected industry were withheld to avoid possible disclosure of information about operations of individual companies (i.e., these data cells are marked with the symbol "D").

In addition to *Research and Development in Industry: 1988*, the following NSF publications also contain the $356 million overcount:

a. *National Patterns of R&D Resources: 1990* (NSF 90-316) Revised data will be printed in the next edition of this report.
b. *Science and Technology Data Book: 1990* (NSF 90-304) Revised data will be printed in the next edition of this report.

A third publication, a Technical Note that is a companion to this present volume, *Estimating Basic and Applied Research and Development in Industry: A Preliminary Review of Survey Procedures*, in press, contains the corrected data.

survey definitions[5]

Research and development—Basic and applied research in the sciences and engineering and the design and development of prototypes and processes. This definition excludes quality control, routine product testing, market research, sales promotion, sales service, other nontechnological activities or routine technical services, and research in the social sciences or psychology.

Basic research—Original investigations for the advancement of scientific knowledge not having specific immediate commercial objectives, although such investigations may be in fields of present or potential interest to the reporting company.

Applied research—Investigations for the discovery of new scientific knowledge having specific commercial objectives with respect to products or processes. This definition differs from that of basic research chiefly in terms of the objectives of the reporting company.

Development—Technical activities of a nonroutine nature concerned with translating research findings or other scientific knowledge into products or processes. Not included are routine technical services to customers or other activities excluded from the foregoing definition of R&D.

See next subsection, **Explanation of Tabular Data,** for a discussion of the format in which these data are being published.

Full-time-equivalent (FTE)—The number of scientists and engineers in the company who are assigned full time to R&D projects together with the fraction of total work time spent on R&D projects by non-full-time R&D scientists and engineers.

Funds for r&d—Operating expenses incurred by a company in the conduct of R&D in its own laboratories or other company-owned or -operated facilities. These expenses include wages and salaries, materials and supplies consumed, property and other taxes, maintenance and repairs, depreciation, and an appropriate share of overhead, but exclude capital expenditures. Except where indicated in table B-1, all funds for R&D performance are expressed in current, rather than constant, dollars.

Company (and other) funds for r&d—Cost of R&D actually performed within the company, and funded by the company itself or by other non-Federal sources via contract. These data therefore do not include the cost of R&D supported by companies but contracted to outside organizations, such as research institutions, universities and colleges, nonprofit organizations, or (to avoid double-counting) other companies. Since it is a survey of R&D performers, industrial firms that undertake R&D supported by outside organizations do report the funds received in payment for the R&D work they perform. These monies are classified under the industries of the *performing* companies.

Federal funds for r&d—Represents receipts for R&D performed by the company on Federal R&D contracts or subcontracts and R&D portions of procurement contracts and subcontracts.

Federally funded research and development centers (FFRDCs)—R&D-performing organizations administered by industrial, educational, or other institutions on a nonprofit basis, exclusively or substantially financed by the Federal Government. FFRDCs are supported by the Federal Government either to meet a particular R&D objective or, in some instances, to provide major facilities at universities for research and associated training purposes. R&D expenditures of the FFRDCs that are industry-administered are included with the Federal R&D data of the industry classification of each of the administering firms.

R&D scientists and engineers—The January number of those engaged full time in R&D and the full-time equivalent of those working part time in R&D. Scientists and engineers are defined as persons engaged in scientific or engineering work at a level that requires knowledge of physical, life, engineering, or mathematical science equivalent at least to that acquired through completion of a 4-year college program with a major in one of those fields.

Employment—Total number of persons domestically employed by

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[5] For more detailed definitions, as well as the instruction sheet sent to survey respondents, see section D.

R&D-performing companies in all activities during the pay period that includes the 12th of March. These data are not completely comparable with the data on R&D scientists and engineers described in the foregoing paragraph because the earlier data are collected for January of each year.

Net sales and receipts—Recorded dollar values for goods sold or services rendered by R&D-performing companies to customers (outside the company), including the Federal Government, less such items as returns, allowances, freight, charges, and excise taxes. Domestic intracompany transfers and sales by foreign subsidiaries are excluded, but transfers to foreign subsidiaries and export sales to foreign companies are included.

Geographic area covered—Includes only those operations located in the 50 States and the District of Columbia.[6]

explanation of tabular data

Classification of reporting units—The basic reporting unit is the company or corporate family that includes all establishments under common ownership or control. All R&D expenditures and all scientists and engineers of each company are classified into a single SIC code[7] and size-category.

Industry classification—Census staff assigned an enterprise-level SIC code to each company. A single SIC code was assigned to multiestablishment companies, based on the code which represented the most dominant aggregated activity for that firm (in terms of total payroll.)[7] Data for the following industry groupings [with SIC code(s) shown in parentheses[8]] are published in this report:

- Food and tobacco (20,21)[9]
- Textiles and apparel (22,23)
- Lumber, wood products, and furniture (24,25)
- Paper and allied products (26)
- Chemicals and allied products (28)
  - Industrial chemicals (281-82,286)
  - Drugs and medicines (283)
  - Other chemicals (284-85,287-89)
- Petroleum refining and extraction (13,29)
- Rubber products (30)
- Stone, clay, and glass products (32)
- Primary metals (33)
  - Ferrous metals and products (331-32,3398-99)
  - Nonferrous metals and products (333-36)
- Fabricated metal products (34)
- Machinery (35)
  - Office, computing, and accounting machines (357)
  - Other machinery, except electrical (351-56,358-59)
- Electrical equipment (36)
  - Radio and TV receiving equipment (365)
  - Communication equipment (366)
  - Electronic components (367)
  - Other electrical equipment (361-64,369)
- Transportation equipment (37)
  - Motor vehicles and motor vehicles equipment (371)
  - Other transportation equipment (373-75,379)
  - Aircraft and missiles (372,376)[10]
- Professional and scientific instruments (38)
  - Scientific and mechanical measuring instruments (381-82)
  - Optical, surgical, photographic, and other instruments (383-87)
- Other manufacturing industries[9]—printing and publishing (27), leather products (31), and miscellaneous manufacturing industries (39)
- Nonmanufacturing industries—mining (10-11,14); construction (15-17); transportation, communications, electric, gas, and sanitary services (40-42,44-49); wholesale and retail trade (50-51,53-54,56); finance, insurance, and real estate (60,62-63); personal and business services (72-73); motion pictures (78); health services (806-07); and engineering, accounting, research, management, and related services (87)

Company size-class—Companies are categorized by their total number of domestic employees. The following are the six company size-classes used in this report: fewer than 500 employees; 500 to 999 employees; 1,000 to 4,999 employees; 5,000 to 9,999 employees; 10,000 to 24,999 employees; and 25,000 or more employees.

Cost per R&D scientist or engineer—The number of FTE R&D scientists and engineers used to estimate the cost per R&D scientist or engineer for 1978-88 is the arithmetic mean of the numbers of FTE R&D scientists and engineers reported for January in two consecutive years. This number is then divided into the total R&D expenditures of the earlier year, and the ratio is attributed to the earlier year. For example, the mean of the numbers of FTE R&D scientists and engineers in January 1988 and January 1989 is divided into total 1988 R&D expenditures for a total cost per R&D scientist or engineer in 1988.

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[6] Company-sponsored R&D performed outside the United States by foreign subsidiaries of U.S. domestic companies is reported in table B-10 but excluded from all other tables.

[7] An exception was made for most of the companies classified in SIC code 13 (oil and gas extraction) and SIC code 50 (wholesale trade, durable goods). Because the R&D activity of these companies is in manufacturing product areas rather than service areas, their R&D expenditures were included with the SIC classifications of the manufacturing codes which encompassed the highest dollar-value of their payroll. The R&D of all such firms in SIC 13 were included with the firms in SIC 29 (petroleum). There were several manufacturing SIC codes that received the R&D expenditures of these types of firms in SIC 50.

[8] When the sample was drawn in 1987, the 1972 SIC code numbers were in effect. For the convenience of researchers who may want to cross-reference these data with current data from other sources, the stubs of the tables contain the new SIC codes. Thus, in table B-1, research and development laboratories are listed under the 2-digit SIC code 87, although they carried an SIC code of 73 when they were originally selected.

[9] Until 1984, tobacco products (SIC 21) was included with "other manufacturing industries."

[10] Companies primarily engaged in the manufacture of ordnance and accessories, including complete guided missiles, are grouped with companies primarily engaged in the manufacture of aircraft and parts because of the close similarity of their R&D activities.

Method of computation—Because of rounding, detailed statistics in tables may not add to totals or subtotals. Also, percentages were calculated on the basis of thousands of dollars and may differ from those based on rounded figures shown.

Nonavailability of statistics—Census staff conduct the survey under Title 13 of the U.S. code which prohibits publication or release of data that may reveal information about individual companies. Therefore, some of the Detailed Statistical Tables, section B, contain one or both of the following footnotes:

- "(D)," which is used to indicate data are being withheld to avoid possible disclosure of information about operations of individual companies. This occurs when a small number of companies, usually one or two, accounts for a large percentage of the R&D funds or of scientists and engineers in a particular data cell. The tables most often affected by this rule are those that contain data on Federal support to companies for R&D performance; and
- "(S)," which is used to indicate that the imputation rate—the percentage of the statistic not reported by respondents and consequently estimated by Census staff—exceeds 50 percent for that item. Users should consult table A-2 for imputation rates for specific items.

Although publication of data may be withheld from certain cells, they are always included in totals. In some instances, data withheld because of high imputation rates (footnote reference "(S)") can be derived by subtraction from higher-level totals. In such cases, the user should be aware that the derived numbers are statistically unreliable. In *no* instance can data be derived that would disclose operations of individual companies (footnote "(D)").

Procedure for publication of detail on basic research, applied research, and development (character of work) expenditures—Over the years there have been concerns about the response rate for questions on basic research, applied research, and development data, and about the ability of Census to produce estimates of national totals for these data items having low response rates. There is a two-fold difficulty in collecting these character-of-work details: (1) To minimize reporting burden, the non panel firms in the sample, which are small in terms of R&D expenditures, do not receive a questionnaire asking for the breakdown of their R&D expenditures into character of work categories. (2) There is a relatively low response rate for these data items from the companies which are asked to provide a breakdown of their R&D into basic research, applied research, and development expenditures. Consequently, Census distributed only approximately 70 percent of total estimated industrial R&D into these character of work categories. Census did not distribute the remaining 30 percent of industrial R&D; as a result, character-of-work tables have not been published in the *Research and Development in Industry* for the past three years.

For the first time, however, data on industrial basic research, applied research, and development expenditures are being published in a separate technical report, *Estimating Basic and Applied Research and Development in Industry: A Preliminary Review of Survey Procedures*, in press. The report contains several versions of tables showing data for 1986, 1987, and 1988. The tables illustrate how estimated figures for basic research, applied research, and development can vary depending on assumptions made about the Census' "not-distributed" category of R&D expenditures. Explanations of the assumptions underlying different estimates are provided, along with an overview of the Survey of Research and Development in Industry and an explanation of some general problems of missing information.

section b

detailed statistical tables

To obtain accurate historical data, use only the latest detailed statistical tables and not data published earlier. Data in trend tables are assembled from the most recently completed survey cycle. Data for prior years are reviewed for consistency with current-year responses and revised when necessary. For that reason, references to prior-year data should be restricted to those published in this document.

Data on all tables are reported in terms of *current* dollars. For the convenience of the researcher, constant dollars are also presented in one summary trend table, table B-1.

Because of rounding, details may not add to totals.

Percentages were calculated on the basis of thousands of dollars and may differ from those based on the rounded figures shown.

The publication or release of data that may reveal information about individual companies is prohibited by law. Therefore, on some tables, the symbol "(D)" is used to indicate that data are being withheld to avoid possible disclosure of information of individual companies. This occurs when a small number of companies accounts for a large percentage of the data in a particular cell.

Footnote reference "(S)" is used to indicate that the imputation rate—the percentage of the statistic estimated by Census staff—exceeds 50 percent. This means respondents failed to provide data for that item on the questionnaire. Interested users should consult table A-2 for imputation rates for specific items.

Although publication of data may be withheld from certain cells, the data are always included in totals. In some instances, data withheld because of high imputation rates (footnote "(S)") can be derived by subtraction from higher-level totals. In such cases, the user should be aware that the derived numbers are statistically unreliable. In *no* instance can data be derived that would disclose operations of individual companies (footnote "(D)").

Shortly before publication of this document, NSF staff discovered that an error in processing 1986 data had been made, resulting in an overcount of $356 million. The 1986 industry R&D total (company, Federal, and other) funds should actually be $87,823 million instead of $88,179 million printed in this report, and the Federal total should be $27,891 million instead of $28,247 million. The data will be corrected in future publications. No change will be made to published individual industry data, however, because data for the affected industry were withheld to avoid possible disclosure of information about operations of individual companies (footnote reference "(D)").

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[Dollars in millions]

Year	Total R&D		Federal		Company(1)	
	Current dollars	Constant 1982 dollars	Current dollars	Constant 1982 dollars	Current dollars	Constant 1982 dollars
1953	$3,630	$14,021	$1,430	$5,523	$2,200	$8,497
1954	4,070	15,475	1,750	6,654	2,320	8,821
1955	4,640	17,090	2,180	8,029	2,460	9,061
1956	6,605	23,530	3,328	11,856	3,277	11,674
1957	7,731	26,585	4,335	14,907	3,396	11,678
1958	8,389	28,274	4,759	16,040	3,630	12,235
1959	9,618	31,597	5,635	18,512	3,983	13,085
1960	10,509	33,955	6,081	19,648	4,428	14,307
1961	10,908	34,917	6,240	19,974	4,668	14,942
1962	11,464	35,892	6,434	20,144	5,029	15,745
1963	12,630	38,981	7,270	22,438	5,360	16,543
1964	13,512	41,032	7,720	23,444	5,792	17,589
1965	14,185	41,992	7,740	22,913	6,445	19,079
1966	15,548	44,474	8,332	23,833	7,216	20,641
1967	16,385	45,590	8,365	23,275	8,020	22,315
1968	17,429	46,194	8,560	22,688	8,869	23,506
1969	18,308	46,023	8,451	21,244	9,857	24,779
1970	18,067	42,986	7,779	18,508	10,288	24,478
1971	18,320	41,280	7,666	17,274	10,654	24,006
1972	19,552	42,056	8,017	17,245	11,535	24,812
1973	21,249	42,893	8,145	16,441	13,104	26,451
1974	22,887	42,415	8,220	15,234	14,667	27,181
1975	24,187	40,781	8,605	14,509	15,582	26,272
1976	26,997	42,805	9,561	15,159	17,436	27,645
1977	29,825	44,330	10,485	15,584	19,340	28,746
1978	33,304	46,115	11,189	15,493	22,115	30,622
1979	38,226	48,652	12,518	15,932	25,708	32,720
1980	44,505	51,919	14,029	16,366	30,476	35,553
1981	51,810	55,140	16,382	17,435	35,428	37,705
1982	58,650	58,650	18,545	18,545	40,105	40,105
1983	65,268	62,842	20,680	19,911	44,588	42,931
1984	74,800	69,433	23,396	21,717	51,404	47,716
1985	84,239	75,925	27,196	24,512	57,043	51,413
1986	88,179	77,472	28,247	24,817	59,932	52,655
1987	94,117	80,168	31,311	26,670	62,806	53,497
1988	99,422	81,977	32,959	27,176	66,463	54,801
1989 (NSF estimate)	103,000	81,333	34,200	27,006	68,800	54,327
1990 (NSF estimate)	108,150	81,950	35,650	27,014	72,500	54,937

(1) Company funds include funds for industrial R&D work performed within company facilities from all sources except the Federal government. The sources may comprise outside organizations such as research institutins, universities and colleges, other nonprofit organizations, other companies, and and state governments, as well as companies' own funds. Company-financed R&D not performed within the company is excuded.

Notes: NSF estimates are published in National Patterns of R&D Resources: 1990
The 1982 GNP implicit price deflator was used to convert current to constant dollars.

SOURCE: National Science Foundation, SRS

Table B-2. Selected data for R&D-performing companies by industry: 1987-88

[Dollars in millions]

Industry(1)	SIC code	R&D Funds Total		Federal		Company		Domestic net sales		R&D scientists & engineers [in thousands] January		Domestic employment [in thousands] March	
		1987	1988	1987	1988	1987	1988	1987	1988	1988	1989	1987	1988
Total		$94,117	$99,422	$31,311	$32,959	$62,806	$66,463	$2,282,903	$2,338,884	708.6	724.9	17,633	17,000
Food and kindred products	20	852	844	2	(D)	850	(D)	185,152	198,563	(S)	(D)	1,152	1,124
Tobacco manufactures	21	371	(D)	0	0	371	(D)	34,241	34,650	2.1	(D)	155	159
Textile mill products	22	185	(D)	0	(D)	185	142	41,035	(S)	1.8	(S)	451	(S)
Apparel	23	(D)	(D)	(D)	(D)	46	38	12,644	(S)	0.6	(S)	203	(S)
Lumber and wood products, except furniture	24	41	45	0	0	41	45	9,736	9,858	0.4	(S)	79	80
Furniture and fixtures	25	99	(D)	0	(D)	99	110	15,579	14,543	0.9	(S)	175	178
Paper and allied products	26	(D)	(D)	(D)	(D)	603	657	104,152	87,273	6.1	(S)	559	558
Printing, publishing, and allied industries	27	(D)	(D)	(D)	(D)	154	142	23,942	22,361	(S)	(S)	247	226
Chemicals and allied products	28	9,878	10,774	192	195	9,685	10,580	187,751	198,368	75.8	77.4	1,091	1,064
Petroleum refining and extraction	13,29	1,897	1,958	14	21	1,883	1,937	182,068	182,652	9.5	10.0	454	412
Rubber products	30	(D)	(D)	(D)	(D)	635	651	38,572	39,837	(S)	(S)	491	(S)
Leather and leather products	31	19	17	0	0	19	17	1,889	1,416	(S)	(S)	14	(S)
Stone, clay, and glass products	32	998	(D)	10	(D)	988	945	38,988	36,936	8.6	8.3	357	314
Primary metals	33	744	663	19	21	725	643	80,317	79,029	5.6	5.6	481	436
Fabricated metal products	34	949	951	150	142	799	808	64,093	60,942	10.5	(S)	601	575
Machinery	35	(D)	(D)	(D)	(D)	10,819	12,132	152,691	162,199	98.4	99.7	1,450	1,454
Electrical equipment	36	16,053	16,744	5,452	5,551	10,602	11,193	195,514	206,281	132.5	139.9	2,010	1,965
Transportation	37	(D)	(D)	(D)	(D)	13,593	14,009	395,982	406,726	188.2	192.8	2,739	2,574
Professional and scientific instruments	38	5,264	5,561	273	215	4,991	5,346	66,623	72,256	(S)	(S)	632	631
Miscellaneous manufacturing industries	39	(D)	(D)	(D)	(D)	221	218	9,309	9,285	4.3	(S)	92	89
Communication services	48,part 737	1,503	1,398	418	276	1,085	1,122	59,039	76,530	10.3	9.2	466	486
Electric, gas, and sanitary services	49	266	256	11	21	255	235	141,882	151,595	1.7	1.7	564	573
Computer programming, data processing, other computer-related, engineering, architectural, and surveying services	part 737,871	3,805	3,874	1,392	1,507	2,413	2,367	32,952	35,315	53.6	(S)	405	402
Hospitals; medical and dental laboratories	806-07	121	151	3	2	118	149	6,087	6,519	1.7	(S)	946	947
Research, development, and testing services	873	919	907	343	247	576	660	10,420	10,440	9.1	9.1	25	24
Other nonmanufacturing industries	10-11,14-17,40-42,44-47,50-51,53-54,56,60,62-63,72-73,78,872,874	2,076	2,132	1,027	1,090	1,049	1,042	192,244	180,490	26	29	1,959	1,614

(1) Industries, industry groups, and product fields shown separately are classified according to Standard Industrial Classification (SIC) manual codes.

(D) Data have been withheld to avoid disclosing operations of individual companies.

(S) Data have been withheld due to imputation of more than 50 percent.

SOURCE: National Science Foundation, SRS

Table B-3. Total (company, Federal, and other) funds for industrial R&D performance by industry: 1978-88

[Dollars in millions]

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Total		$33,304	$38,226	$44,505	$51,810	$58,650	$65,268	$74,800	$84,239	$88,179	$94,117	$99,422
Distribution by industry												
Food, kindred, and tobacco products(1)	20,21	472	528	620	(D)	(D)	(D)	(D)	(D)	(D)	1,223	(D)
Textiles and apparel	22,23	89	101	115	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Lumber, wood products, and furniture	24,25	126	139	148	161	159	152	143	147	144	140	(D)
Paper and allied products	26	387	445	495	(D)	566	(D)	(D)	(D)	(D)	(D)	(D)
Chemicals and allied products	28	3,580	4,038	4,636	5,625	6,604	7,185	7,927	8,540	8,843	9,878	10,774
Industrial chemicals	281-82,286	1,798	1,962	2,197	2,802	3,206	3,214	3,240	3,498	3,552	3,901	3,959
Drugs and medicines	283	1,308	1,517	1,777	(D)	(D)	(D)	(D)	(D)	3,658	(D)	4,737
Other chemicals	284-85,287-89	474	559	662	(D)	(D)	(D)	(D)	(D)	1,633	(D)	2,078
Petroleum refining and extraction	13,29	1,060	1,262	1,552	(D)	(D)	(D)	(D)	(D)	(D)	1,897	1,958
Rubber products	30	493	577	656	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Stone, clay, and glass products	32	324	356	406	(D)	(D)	(D)	(D)	(D)	950	998	(D)
Primary metals	33	560	634	728	878	987	1,085	(D)	(D)	(D)	744	663
Ferrous metals and products	331-32,3398-99	314	375	443	(D)	(D)	(D)	(D)	(D)	(D)	(D)	260
Nonferrous metals and products	333-36	246	259	285	(D)	(D)	(D)	336	416	458	(D)	403
Fabricated metal products	34	384	455	550	624	625	701	842	829	895	949	951
Machinery	35	4,283	4,825	5,901	6,818	8,078	9,027	10,504	12,216	(D)	(D)	(D)
Office, computing, and accounting machines	357	2,883	3,214	3,962	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Other machinery, except electrical	351-56,358-59	1,400	1,611	1,939	(D)	(D)	(D)	(D)	(D)	2,396	2,605	2,766
Electrical equipment	36	6,507	7,824	9,175	10,329	10,923	12,681	13,778	14,432	14,980	16,053	16,744
Radio and TV receiving equipment	365	130	245	556	(D)	(D)	(D)	(D)	(D)	133	143	138
Communication equipment	366	2,999	3,635	4,024	4,758	5,839	7,298	8,685	9,397	9,669	10,311	10,387
Electronic components	367	902	1,169	1,547	1,573	1,740	2,169	2,831	3,385	(D)	4,342	5,039
Other electrical equipment	361-64,369	2,476	2,775	3,048	(D)	(D)	(D)	(D)	(D)	(D)	1,257	1,180
Transportation equipment	37	11,546	12,709	14,315	(D)	(D)	(D)	(D)	(D)	31,275	34,377	36,224
Motor vehicles and motor vehicles equipment	371	3,879	4,509	4,955	4,806	4,797	5,318	6,057	6,984	(D)	(D)	(D)
Other transportation equipment	373-75,379	131	159	162	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Aircraft and missiles	372,376	7,536	8,041	9,198	11,968	14,451	15,406	18,858	22,231	21,050	24,488	25,667

See footnotes at end of

Table B-3. Total (company, Federal, and other) funds for industrial R&D performance by industry: 1978-88 (continued)

[Dollars in millions]

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Distribution by industry												
Professional and scientific instruments	38	$1,998	$2,505	$3,029	$3,614	$3,930	$4,266	$4,602	$5,013	$5,103	$5,264	$5,561
Scientific and mechanical measuring instruments	381-82	670	950	1,352	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Optical, surgical, photographic, and other instruments	383-87	1,328	1,555	1,677	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Other manufacturing industries (1)	27,31,39	266	288	364	(D)	(D)	(D)	(D)	(D)	382	(D)	(D)
Nonmanufacturing industries	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	1,229	1,540	1,815	1,906	2,472	3,337	4,905	6,714	7,446	8,690	8,718
Distribution by size of company [Based on number of employees]												
Less than 500		1,438	1,764	2,065	2,305	2,934	4,422	4,402	5,866	7,071	7,603	(S)
500 to 999								1,439	1,648	1,902	1,911	1,740
1,000 to 4,999		1,931	2,483	2,701	3,148	3,864	4,178	5,520	6,240	7,472	8,129	8,391
5,000 to 9,999		1,551	1,691	2,028	2,988	2,751	2,798	3,251	4,022	4,251	4,488	5,571
10,000 to 24,999		4,278	5,191	6,017	6,762	7,943	9,499	11,351	11,109	10,493	12,480	11,564
25,000 or more		24,106	27,097	31,693	36,607	41,156	44,372	48,837	55,354	56,991	59,506	64,704

(D) Data have been withheld to avoid disclosing operations of individual companies.
(1) Until 1984, tobacco products (SIC 21) was included with "other manufacturing industries."

SOURCE: National Science Foundation, SRS

Table B-4. Total (company, Federal, and other) funds for industrial R&D performance, by industry and size of company: 1988

[Dollars in millions]

Industry	SIC code	Total funds	Companies with total employment of-- Less than 500 employees	500 to 999 employees	1,000 to 4,999 employees	5,000 to 9,999 employees	10,000 to 24,999 employees	25,000 or more employees
Total		$99,422	(S)	$1,740	$8,391	$5,571	$11,564	$64,704
Food, kindred, and tobacco products	20,21	(D)	(S)	(S)	127	136	(D)	815
Textiles and apparel	22,23	(D)	(D)	(S)	(D)	14	51	(S)
Lumber, wood products, and furniture	24,25	(D)	(D)	9	61	(D)	53	(D)
Paper and allied products	26	(D)	(S)	(S)	81	67	319	(D)
Chemicals and allied products	28	10,774	(D)	(D)	1,718	(D)	(D)	(D)
Industrial chemicals	281-82,286	3,959	38	(D)	(D)	(D)	(D)	(D)
Drugs and medicines	283	4,737	(D)	(D)	(D)	(D)	(D)	(D)
Other chemicals	284-85,287-89	2,078	492	71	450	(D)	578	(D)
Petroleum refining and extraction	13,29	1,958	(D)	(D)	(D)	(D)	(D)	1,572
Rubber products	30	(D)	(S)	(D)	(D)	(D)	110	(D)
Stone, clay, and glass products	32	(D)	(S)	(S)	40	43	(D)	(D)
Primary metals	33	663	(D)	(D)	(D)	(D)	(D)	(D)
Ferrous metals and products	331-32,3398-99	260	(S)	(D)	(D)	(D)	52	(D)
Nonferrous metals and products	333-36	403	(D)	(S)	(D)	(D)	(D)	(D)
Fabricated metal products	34	951	(D)	(D)	(D)	(D)	397	0
Machinery	35	(D)	1,212	432	1,478	1,302	(D)	(D)
Office, computing, and accounting machines	357	(D)	(S)	280	(D)	1,112	(D)	7,660
Other machinery, except electrical	351-56,358-59	2,766	790	152	(D)	190	(D)	(D)
Electrical equipment	36	16,744	1,443	295	1,178	985	1,819	11,024
Radio and TV receiving equipment	365	138	(S)	(D)	13	0	(D)	0
Communication equipment	366	10,387	410	87	379	(D)	(S)	(D)
Electronic components	367	5,039	(D)	(D)	(D)	(D)	1,009	2,179
Other electrical equipment	361-64,369	1,180	(D)	71	(D)	139	(D)	(D)
Transportation equipment	37	36,224	(D)	(D)	(D)	(D)	2,017	(D)
Motor vehicles and motor vehicles equipment	371	(D)	(D)	15	(D)	119	(D)	(D)
Other transportation equipment	373-75,379	(D)	(D)	7	24	(D)	(D)	0
Aircraft and missiles	372,376	25,667	(D)	(D)	174	(D)	1,395	23,963

See footnotes at end of

Table B-4. Total (company, Federal, and other) funds for industrial R&D performance, by industry and size of company: 1988 (continued)

[Dollars in millions]

Industry	SIC code	Total funds	Companies with total employment of--					
			Less than 500 employees	500 to 999 employees	1,000 to 4,999 employees	5,000 to 9,999 employees	10,000 to 24,999 employees	25,000 or more employees
Professional and scientific instruments	38	$5,561	(S)	(D)	$555	(D)	$393	(D)
Scientific and mechanical measuring instruments.	381-82	(D)	303	69	(D)	(D)	(D)	(D)
Optical, surgical, photographic, and other instruments	383-87	(D)	(S)	(D)	(D)	(D)	(D)	(D)
Other manufacturing industries	27,31,39	(D)	(D)	(D)	(D)	82	119	(D)
Nonmanufacturing industries	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	8,718	(S)	466	2146	(D)	343	(D)

(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of more than 50 percent.

SOURCE: National Science Foundation, SRS

Table B-5. Total (company, Federal, and other) funds for industrial R&D performance by industry, size of R&D program, and size of company: 1988

Industry and size of company	SIC code	Total	Size of R&D program [Dollars in thousands]				
			Less than $200	$200 to $999	$1,000 to $9,999	$10,000 to $99,999	$100,000 or more
					[Dollars in millions]		
Total		$99,422	(S)	(S)	$6,476	$13,005	$76,626
Food, kindred, and tobacco products	20,21	(D)	(S)	(S)	143	722	(D)
Textiles and apparel	22,23	(D)	(D)	(S)	77	76	0
Lumber, wood products, and furniture	24,25	(D)	(D)	15	54	81	0
Paper and allied products	26	(D)	(S)	(S)	76	411	(D)
Chemicals and allied products	28	10,774	(S)	(S)	641	1,715	8,147
Industrial chemicals	281-82,286	3,959	(D)	(D)	113	858	2,969
Drugs and medicines	283	4,737	(S)	(S)	56	327	4,302
Other chemicals	284-85,287-89	2,078	(D)	(D)	472	530	876
Petroleum refining and extraction	13,29	1,958	(S)	(S)	30	531	1,390
Rubber products	30	(D)	(S)	(S)	106	277	(D)
Stone, clay, and glass products	32	(D)	(S)	(S)	52	(D)	(D)
Primary metals	33	663	(D)	(S)	118	386	(D)
Ferrous metals and products	331-32,3398-99	260	(S)	(S)	45	197	0
Nonferrous metals and products	333-36	403	(D)	(S)	73	189	(D)
Fabricated metal products	34	951	(D)	(S)	(S)	408	(D)
Machinery	35	(D)	(S)	(S)	995	2,465	(D)
Office, computing, and accounting machines	357	(D)	(D)	(S)	478	1,228	9,026
Other machinery, except electrical	351-56,358-59	2,766	(D)	(S)	517	1,237	(D)
Electrical equipment	36	16,744	(S)	(S)	1,392	1,693	13,163
Radio and TV receiving equipment	365	138	(D)	(S)	19	0	(D)
Communication equipment	366	10,387	(S)	(S)	378	478	9,390
Electronic components	367	5,039	(S)	(S)	679	689	3,490
Other electrical equipment	361-64,369	1,180	(D)	(S)	316	526	(D)
Transportation equipment	37	36,224	(D)	(S)	143	(D)	35,316
Motor vehicles and motor vehicles equipment	371	(D)	(S)	(S)	74	224	(D)
Other transportation equipment	373-75,379	(D)	(S)	(D)	34	(D)	(D)
Aircraft and missiles	372,376	25,667	(D)	(D)	35	311	25,314

See footnotes at end of

Table B-5. Total (company, Federal, and other) funds for industrial R&D performance by industry, size of R&D program, and size of company: 1988 (continued)

Industry and size of company	SIC code	Total	Less than $200	$200 to $999	$1,000 to $9,999	$10,000 to $99,999	$100,000 or more
			Size of R&D program [Dollars in thousands]				
			[Dollars in millions]				
Professional and scientific instruments	38	5,561	(S)	(S)	469	635	4,150
Scientific and mechanical measuring instruments	381-82	(D)	(S)	(S)	263	284	(D)
Optical, surgical, photographic, and other instruments	383-87	(D)	(S)	(S)	206	351	(D)
Other manufacturing industries	27,31,39	(D)	(D)	(S)	116	235	0
Nonmanufacturing industries	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	8,718	(S)	(S)	1,737	2,441	3,145
Distribution by size of company [Based on number of employees]							
Less than 500		(S)	(S)	(S)	3,496	979	0
500 to 999		1,740	(S)	(S)	745	831	0
1,000 to 4,999		8,391	(S)	(S)	1,688	5,119	1,431
5,000 to 9,999		5,571	(S)	(S)	318	1,899	3,338
10,000 to 24,999		11,564	(D)	(D)	195	3,150	8,212
25,000 or more		64,704	(D)	(D)	34	1,027	63,645

(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of more than 50 percent.

SOURCE: National Science Foundation, SRS

Table B-6. Number of R&D-performing companies by industry, size of company, and size of R&D program: 1988

Industry and size of company	SIC code	Total	Size of R&D program [Dollars in thousands] Less than $200	$200 to $999	$1,000 to $9,999	$10,000 to $99,999	$100,000 or more
Total...................................	....	24,992	16,951	5,389	2,074	456	122
Food, kindred, and tobacco products..................	20,21	137	29	46	37	23	2
Textiles and apparel..................................	22,23	463	400	33	25	5	0
Lumber, wood products, and furniture.................	24,25	156	101	29	21	5	0
Paper and allied products.............................	26	328	122	168	23	14	1
Chemicals and allied products........................	28	2,475	1,909	316	178	45	27
Industrial chemicals...............................	281-82,286	254	204	1	23	19	7
Drugs and medicines................................	283	442	301	102	14	8	17
Other chemicals....................................	284-85,287-89	1,779	1,404	213	141	18	3
Petroleum refining and extraction....................	13,29	135	104	6	8	12	5
Rubber products.......................................	30	491	391	61	28	10	1
Stone, clay, and glass products......................	32	158	90	40	18	8	2
Primary metals..	33	262	178	37	28	18	1
Ferrous metals and products........................	331-32,3398-99	122	83	18	11	10	0
Nonferrous metals and products.....................	333-36	140	95	19	17	8	1
Fabricated metal products............................	34	2,077	1,718	162	184	12	1
Machinery...	35	2,831	1,708	619	394	96	14
Office, computing, and accounting machines.........	357	508	101	110	241	45	11
Other machinery, except electrical.................	351-56,358-59	2,323	1,607	509	153	51	3
Electrical equipment.................................	36	3,712	2,358	882	384	64	24
Radio and TV receiving equipment...................	365	180	147	27	5	0	1
Communication equipment............................	366	671	303	247	89	19	13
Electronic components..............................	367	1,363	698	427	202	27	9
Other electrical equipment.........................	361-64,369	1,498	1,210	181	88	18	1
Transportation equipment.............................	37	275	33	155	41	22	24
Motor vehicles and motor vehicles equipment........	371	161	7	121	21	8	4
Other transportation equipment.....................	373-75,379	69	24	28	13	2	2
Aircraft and missiles..............................	372,376	45	2	6	7	12	18

Table B-6. Number of R&D-performing companies by industry, size of company, and size of R&D program: 1988 (continued)

Industry and size of company	SIC code	Total	Size of R&D program [Dollars in thousands] Less than $200	$200 to $999	$1,000 to $9,999	$10,000 to $99,999	$100,000 or more
Scientific and mechanical measuring instruments....	381-82	1,023	680	252	76	13	2
Optical, surgical, photographic, and other instruments....................................	383-87	902	523	298	58	16	7
Other manufacturing industries......................	27,31,39	397	332	28	29	8	0
Nonmanufacturing industries..........................	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	9,170	6,275	2,257	542	85	11
Distribution by size of company [Based on number of employees]							
Less than 500..................................	....	22,621	16,419	4,827	1,327	48	0
500 to 999..................................	....	790	270	268	207	45	0
1,000 to 4,999..................................	....	1,083	226	250	418	181	8
5,000 to 9,999..................................	....	189	14	27	70	63	15
10,000 to 24,999..................................	....	187	5	11	45	90	36
25,000 or more..................................	....	122	17	6	7	29	63

SOURCE: National Science Foundation, SRS

Table B-7. Company and other (except Federal) funds for industrial R&D performance by industry: selected years

[Dollars in millions]

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Total		$22,115	$25,708	$30,476	$35,428	$40,105	$44,588	$51,404	$57,043	$59,932	$62,806	$66,463
Distribution by industry												
Food, kindred, and tobacco products(1)	20,21	(D)	(D)	(D)	636	777	824	1,081	1,136	1,280	1,221	1,274
Textiles and apparel	22,23	(D)	(D)	(D)	116	136	150	182	218	246	231	183
Lumber, wood products, and furniture	24,25	126	139	148	161	159	152	143	147	144	140	155
Paper and allied products	26	(d)	(D)	495	566	566	552	594	576	538	603	657
Chemicals and allied products	28	3,250	3,692	4,264	5,205	6,197	6,792	7,736	8,310	8,664	9,685	10,580
Industrial chemicals	281-82,286	1,473	1,617	1,856	2,393	2,810	2,828	3,057	3,281	3,374	3,714	3,767
Drugs and medicines	283	(D)	(D)	1,756	2,064	2,473	2,896	3,310	3,481	3,657	4,139	4,735
Other chemicals	284-85,287-89	(D)	(D)	653	747	914	1,068	1,369	1,548	1,633	1,832	2,078
Petroleum refining and extraction	13,29	939	1,109	1,401	1,780	2,003	2,074	2,245	2,194	1,971	1,883	1,937
Rubber products	30	(D)	(D)	(D)	598	617	638	671	659	655	635	651
Stone, clay, and glass products	32	(D)	(D)	363	411	472	586	705	825	941	988	945
Primary metals	33	497	539	594	702	711	701	683	730	786	725	643
Ferrous metals and products	331-32,3398-99	271	305	338	415	426	396	357	323	336	257	260
Nonferrous metals and products	333-36	226	234	256	287	285	305	326	407	450	468	383
Fabricated metal products	34	348	414	501	545	565	634	773	780	800	799	808
Machinery	35	3,901	4,490	5,254	6,124	7,227	7,911	9,312	10,721	10,701	10,819	12,132
Office, computing, and accounting machines	357	2,556	2,958	3,436	3,847	4,944	5,634	7,011	8,418	8,380	8,260	9,412
Other machinery, except electrical	351-56,358-59	1,345	1,532	1,818	2,277	2,283	2,277	2,301	2,303	2,321	2,559	2,720
Electrical equipment	36	3,741	4,515	5,431	6,409	6,682	8,158	9,037	9,271	9,767	10,602	11,193
Radio and TV receiving equipment	365	102	192	346	358	364	324	362	350	133	143	138
Communication equipment	366	1,763	2,049	2,367	2,975	3,555	4,500	5,147	5,174	5,117	5,533	5,768
Electronic components	367	(D)	(D)	1,165	1,212	1,342	1,810	2,354	2,826	3,357	3,685	4,120
Other electrical equipment	361-64,369	(D)	(D)	1,553	1,864	1,421	1,524	1,174	921	1,160	1,241	1,167
Transportation equipment	37	(D)	(D)	6,958	7,739	8,621	8,991	10,406	12,092	13,567	13,593	14,009
Motor vehicles and motor vehicles equipment	371	3,381	3,780	4,300	4,219	4,321	4,754	5,384	6,164	7,171	7,267	7,769
Other transportation equipment	373-75,379	(D)	(D)	88	80	114	227	258	279	330	357	388
Aircraft and missiles	372,376	1,823	2,201	2,570	3,440	4,186	4,010	4,764	5,649	6,066	5,969	5,852

See footnotes at end of

Table B-7. Company and other (except Federal) funds for industrial R&D performance by industry: selected years (continued)

[Dollars in millions]

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Professional and scientific instruments................	38	$1,668	$2,012	$2,456	$2,978	$3,407	$3,816	$4,211	$4,622	$4,752	$4,991	$5,346
Scientific and mechanical measuring instruments......	381-82	560	747	1,001	1,235	1,363	1,605	1,671	1,596	1,521	1,634	1,672
Optical, surgical, photographic, and other instruments..	383-87	1,108	1,265	1,454	1,743	2,044	2,211	2,540	3,026	3,231	3,357	3,674
Other manufacturing industries (1).....................	27,31,39	266	288	339	411	493	525	373	361	380	394	377
Nonmanufacturing industries............................	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	702	859	1,037	1,048	1,472	2,084	3,252	4,401	4,740	5,496	5,575
Distribution by size of company [Based on number of employees]												
Less than 500..	....	1,226	1,375	1,711	1,880	2,411	3,781	3,781	5,127	6,203	6,583	(S)
500 to 999...	....							1,341	1,531	1,765	1,750	1,613
1,000 to 4,999.......................................	....	1,586	1,893	2,257	2,586	3,241	3,438	4,618	5,249	6,243	6,701	6,868
5,000 to 9,999.......................................	....	1,310	1,463	1,596	2,369	2,224	2,080	2,764	3,350	3,455	3,750	4,614
10,000 to 24,999.....................................	....	3,203	4,012	4,867	5,537	6,448	7,228	8,546	8,366	8,489	10,102	9,717
25,000 or more.......................................	....	14,790	16,965	20,045	23,056	25,781	28,061	30,354	33,421	33,778	33,920	37,126

Notes: Company funds include all funds for industrial R&D work performed within company facilities from all sources except the Federal government. The sources may comprise outside organizations such as research institutions, universities and colleges, other nonprofit organizations, other companies, and state governments, as well as companies'own funds. Company-financed R&D not performed within the company is excluded.

(D) Data have been withheld to avoid disclosing operations of individual companies.
(1) Until 1984, tobacco products (SIC 21) was included with "other manufacturing industries."

SOURCE: National Science Foundation, SRS

Table B-8. Company and other (except Federal) funds for industrial R&D performance by industry and size of company: 1988

[Dollars in millions]

Industry	SIC code	Total funds	Companies with total employment of-- Less than 500 employees	500 to 999 employees	1,000 to 4,999 employees	5,000 to 9,999 employees	10,000 to 24,999 employees	25,000 or more employees
Total		$66,463	(S)	$1,613	$6,868	$4,614	$9,717	$37,126
Food, kindred, and tobacco products	20,21	1,274	(S)	(S)	127	136	170	815
Textiles and apparel	22,23	183	(S)	(S)	49	14	51	(S)
Lumber, wood products, and furniture	24,25	155	(D)	9	61	11	53	(D)
Paper and allied products	26	657	(S)	(S)	81	67	319	130
Chemicals and allied products	28	10,580	597	132	1,700	794	4,129	3,227
Industrial chemicals	281-82,286	3,767	(S)	31	400	402	426	2,470
Drugs and medicines	283	4,735	(S)	30	850	(D)	3,126	(D)
Other chemicals	284-85,287-89	2,078	492	71	450	(D)	578	(D)
Petroleum refining and extraction	13,29	1,937	(D)	(D)	60	47	252	1,567
Rubber products	30	651	(S)	(D)	122	143	110	(D)
Stone, clay, and glass products	32	945	(S)	(D)	40	43	309	(D)
Primary metals	33	643	(S)	(S)	217	94	106	194
Ferrous metals and products	331-32,3398-99	260	(S)	(S)	70	(D)	52	(D)
Nonferrous metals and products	333-36	383	(S)	(S)	147	(D)	54	(D)
Fabricated metal products	34	808	(S)	(S)	117	99	302	0
Machinery	35	12,132	1,208	432	1,453	1,302	914	6,823
Office, computing, and accounting machines	357	9,412	(S)	280	(D)	1,112	441	(D)
Other machinery, except electrical	351-56,358-59	2,720	787	152	(D)	190	473	(D)
Electrical equipment	36	11,193	1,396	254	1,051	691	1,485	6,316
Radio and TV receiving equipment	365	138	(S)	(D)	13	0	(D)	0
Communication equipment	366	5,768	396	(D)	282	105	(D)	4,664
Electronic components	367	4,120	766	98	406	(D)	984	(D)
Other electrical equipment	361-64,369	1,167	(S)	(D)	350	(D)	162	(D)
Transportation equipment	37	14,009	(S)	51	153	199	705	(D)
Motor vehicles and motor vehicles equipment	371	7,769	(D)	(S)	70	(D)	111	(D)
Other transportation equipment	373-75,379	388	(D)	7	24	(D)	327	0
Aircraft and missiles	372,376	5,852	(D)	(D)	59	67	267	5,428

See footnotes at end of

Table B-8. Company and other (except Federal) funds for industrial R&D performance by industry and size of company: 1988 (continued)

[Dollars in millions]

Industry	SIC code	Total funds	Companies with total employment of--					
			Less than 500 employees	500 to 999 employees	1,000 to 4,999 employees	5,000 to 9,999 employees	10,000 to 24,999 employees	25,000 or more employees
Professional and scientific instruments..............	38	$5,346	(S)	$166	$549	$315	$373	$3,430
Scientific and mechanical measuring instruments....	381-82	1,672	294	69	273	(D)	(D)	(D)
Optical, surgical, photographic, and other instruments..	383-87	3,674	(S)	97	276	(D)	(D)	(D)
Other manufacturing industries........................	27,31,39	377	(D)	28	127	82	119	(D)
Nonmanufacturing industries...........................	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	5,575	(S)	405	960	575	323	972

(S) Data have been withheld because of imputation of more than 50 percent.
(D) Data have been withheld to avoid disclosing operations of individual companies.

SOURCE: National Science Foundation, SRS

Table B-9. Company and other (except Federal) funds for industrial R&D performance by selected industry: 1988 actual and 1989 projected

[Dollars in millions]

Industry	SIC code	Actual 1988	1989 (projected)
Total	....	$66,463	(S)
Chemicals and allied products	28	10,580	(S)
Industrial chemicals	281-82,286	3,767	(S)
Machinery	35	12,132	14,222
Electrical equipment	36	11,193	11,297
Communication equipment	366	5,768	5,882
Motor vehicles and motor vehicles equipment	371	7,769	(S)
Aircraft and missiles	372,376	5,852	6,604
All other industries	....	18,937	(S)

(S) Data have been withheld due to imputation of more than 50 percent.

SOURCE: National Science Foundation, SRS

Table B-10. Company-financed research and development performed outside the United States by U.S. domestic companies and their foreign subsidiaries by selected industry: selected years

[Dollars in millions]

Industry	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Total		$2,209	$2,754	$3,165	$3,393	$3,094	$3,269	$3,633	$3,650	$4,624	$5,226	$6,248
Food, kindred, and tobacco products(1)	20,21	43	51	54	62	64	63	70	75	69	37	36
Chemicals and allied products	28	395	500	603	715	682	729	786	843	1,071	1,243	1,540
Industrial and other chemicals	281-82,284-89	151	199	246	287	319	368	385	444	579	625	774
Drugs and medicines	283	244	301	357	428	363	361	401	399	492	618	766
Petroleum refining and extraction	13,29	(2)	(2)	141	194	133	103	101	47	40	47	57
Stone, clay, and glass products	32	(2)	(3)	21	18	10	19	60	(D)	(D)	(D)	(D)
Primary metals	33	9	11	11	9	9	10	9	(D)	(D)	18	19
Fabricated metal products	34	29	(3)	(3)	30	25	23	21	21	26	40	(D)
Machinery	35	460	534	599	612	494	577	740	689	951	1,233	1,360
Electrical equipment	36	352	445	451	475	467	482	537	591	(S)	432	630
Radio and TV receiving equipment	365	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(D)	(D)	0	0
Communication equipment	366							(D)	(D)	(D)	188	(D)
Electronic components	367	17	25	29	40	38	(3)	92	117	150	204	278
Other electrical equipment	361-64,369	9	11	11	39	43	38	30	24	25	39	(D)
Transportation equipment	37	640	874	1,020	884	843	880	907	1,025	(D)	(D)	1,797
Motor vehicles and other transportation equipment	371,373-75,379	(3)	(3)	(3)	(3)	(3)	(3)	(D)	(D)	(D)	(D)	(D)
Aircraft and missiles	372,376	(3)	(3)	(3)	(3)	(3)	(3)	(D)	(D)	182	237	(D)
Professional and scientific instruments	38	121	156	186	230	237	(3)	263	169	212	317	358
Other manufacturing industries	22-27,30-31,39	181	213	139	156	123	92	131	125	141	138	133
Nonmanufacturing industries	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	12	5	7	8	7	10	8	18	27	64	97

Note: Data are reported in current U.S. dollars.

(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of more than 50 percent.
(1) Until 1984, tobacco products, SIC 21, was included with "other manufacturing industries."
(2) Included in the other manufacturing industries group.
(3) Not separately available but included in total. See general notes.

SOURCE: National Science Foundation, SRS

Table B-11. Federal funds for industrial R&D performance by industry: selected years

[Dollars in millions]

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Total		$11,189	$12,518	$14,029	$16,382	$18,545	$20,680	$23,396	$27,196	$28,247	$31,311	$32,959
Distribution by industry												
Food, kindred, and tobacco products(1)	20,21	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	2	(D)
Textiles and apparel	22,23	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Lumber, wood products, and furniture	24,25	0	0	(D)	0	0	0	0	0	0	0	(D)
Paper and allied products	26	(D)	(D)	(D)	(D)	0	(D)	(D)	(D)	(D)	(D)	(D)
Chemicals and allied products	28	330	346	372	421	407	393	191	230	179	192	195
Industrial chemicals	281-82,286	325	345	341	409	396	386	183	217	178	187	192
Drugs and medicines	283	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	1	(D)	3
Other chemicals	284-85,287-89	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	0	(D)	0
Petroleum refining and extraction	13,29	121	153	151	(D)	(D)	(D)	(D)	(D)	(D)	14	21
Rubber products	30	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Stone, clay, and glass products	32	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	9	10	(D)
Primary metals	33	63	95	135	176	276	384	(D)	(D)	(D)	19	21
Ferrous metals and products	331-32,3398-99	43	70	105	(D)	(D)	(D)	(D)	(D)	(D)	(D)	1
Nonferrous metals and products	333-36	20	25	30	(D)	(D)	(D)	10	9	8	(D)	20
Fabricated metal products	34	36	41	49	80	60	67	69	49	95	150	142
Machinery	35	382	335	647	694	851	1,116	1,192	1,495	(D)	(D)	(D)
Office, computing, and accounting machines	357	327	256	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Other machinery, except electrical	351-56,358-59	55	79	(D)	(D)	(D)	(D)	(D)	(D)	75	46	46
Electrical equipment	36	2,766	3,309	3,744	3,920	4,241	4,523	4,741	5,161	5,213	5,452	5,551
Radio and TV receiving equipment	365	28	53	210	(D)	(D)	(D)	(D)	(D)	0	0	0
Communication equipment	366	1,236	1,586	1,657	1,783	2,284	2,798	3,538	4,223	4,552	4,778	4,619
Electronic components	367	(D)	(D)	382	361	398	359	477	559	(D)	657	919
Other electrical equipment	361-64,369	(D)	(D)	1,495	(D)	(D)	(D)	(D)	(D)	(D)	17	13
Transportation equipment	37	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	17,708	20,784	22,215
Motor vehicles and motor vehicles equipment	371	498	729	655	587	476	564	673	820	(D)	(D)	(D)
Other transportation equipment	373-75,379	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Aircraft and missiles	372,376	5,713	5,840	6,628	8,528	10,265	11,396	14,094	16,582	14,984	18,519	19,815

See footnotes at end of

Table B-11. Federal funds for industrial R&D performance by industry: selected years (continued)

[Dollars in millions]

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Professional and scientific instruments.............	38	$330	$493	$573	$637	$523	$450	$391	$391	$351	$273	$215
Scientific and mechanical measuring instruments...	381-82	110	203	350	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Optical, surgical, photographic, and other instruments......................................	383-87	220	290	223	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Other manufacturing industries......................	27,31,39	0	0	25	(D)	(D)	(D)	(D)	(D)	2	(D)	(D)
Nonmanufacturing industries.........................	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	527	681	779	858	1,000	1,253	1,653	2,313	2,706	3,194	3,143
Distribution by size of company [Based on number of employees]												
Less than 500......................................	....	212	389	354	424	523	641	621	739	868	1,020	927
500 to 999...	....							98	117	137	161	127
1,000 to 4,999.....................................	....	345	590	444	562	623	740	902	991	1,229	1,428	1,523
5,000 to 9,999.....................................	....	241	228	432	619	527	718	487	672	796	738	957
10,000 to 24,999...................................	....	1,075	1,179	1,150	1,225	1,495	2,271	2,805	2,743	2,004	2,378	1,847
25,000 or more.....................................	....	9,316	10,132	11,648	13,551	15,377	16,311	18,483	21,933	23,213	25,586	27,578

(D) Data have been withheld to avoid disclosing operations of individual companies.
(1) Until 1984, tobacco products, SIC 21, was included with "other manufacturing industries."
(2) Data not tabulated at this level prior to 1972.
(3) Data not tabulated at this level prior to 1977.
(4) Included in the other electrical equipment group.

SOURCE: National Science Foundation, SRS

Table B-12. Federal funds for industrial R&D performance by industry and size of company: 1988

[Dollars in millions]

Industry	SIC code	Total funds	Companies with total employment of--					
			Less than 500 employees	500 to 999 employees	1,000 to 4,999 employees	5,000 to 9,999 employees	10,000 to 24,999 employees	25,000 or more employees
Total		$32,959	$927	$127	$1,523	$957	$1,847	$27,578
Food, kindred, and tobacco products	20,21	(D)	0	0	0	0	(D)	0
Textiles and apparel	22,23	(D)	(D)	0	(D)	0	0	0
Lumber, wood products, and furniture	24,25	(D)	0	0	0	(D)	0	0
Paper and allied products	26	(D)	0	0	0	0	0	(D)
Chemicals and allied products	28	195	(D)	(D)	18	(D)	(D)	(D)
Industrial chemicals	281-82,286	192	0	(D)	(D)	(D)	(D)	(D)
Drugs and medicines	283	3	(D)	(D)	(D)	0	(D)	(D)
Other chemicals	284-85,287-89	0	0	0	0	0	0	0
Petroleum refining and extraction	13,29	21	0	0	(D)	(D)	(D)	5
Rubber products	30	(D)	0	0	(D)	(D)	0	0
Stone, clay, and glass products	32	(D)	0	(D)	0	0	(D)	(D)
Primary metals	33	21	(D)	(D)	(D)	(D)	(D)	(D)
Ferrous metals and products	331-32,3398-99	1	0	(D)	(D)	(D)	0	(D)
Nonferrous metals and products	333-36	20	(D)	0	(D)	0	(D)	(D)
Fabricated metal products	34	142	(D)	(D)	(D)	(D)	95	0
Machinery	35	(D)	(S)	0	25	0	(D)	(D)
Office, computing, and accounting machines	357	(D)	0	0	(D)	0	(D)	(D)
Other machinery, except electrical	351-56,358-59	46	(S)	0	(D)	0	(D)	(D)
Electrical equipment	36	5,551	(S)	41	127	294	(S)	4,708
Radio and TV receiving equipment	365	0	0	0	0	0	0	0
Communication equipment	366	4,619	14	(D)	97	(D)	(D)	(D)
Electronic components	367	919	(D)	(D)	(D)	(D)	25	(D)
Other electrical equipment	361-64,369	13	(D)	(D)	(D)	(D)	(D)	0
Transportation equipment	37	22,215	(D)	(D)	(D)	(D)	1,314	(D)
Motor vehicles and motor vehicles equipment	371	(D)	0	0	(D)	(D)	(D)	(D)
Other transportation equipment	373-75,379	(D)	0	0	0	(D)	(D)	0
Aircraft and missiles	372,376	19,815	(D)	(D)	114	(D)	1,128	18,535

See footnotes at end of

Table B-12. Federal funds for industrial R&D performance by industry and size of company: 1988 (continued)

[Dollars in millions]

Industry	SIC code	Total funds	Companies with total employment of--					
			Less than 500 employees	500 to 999 employees	1,000 to 4,999 employees	5,000 to 9,999 employees	10,000 to 24,999 employees	25,000 or more employees
Professional and scientific instruments.............	38	$215	$8	(D)	$6	(D)	$20	(D)
Scientific and mechanical measuring instruments...	381-82	(D)	8	0	(D)	0	(D)	0
Optical, surgical, photographic, and other instruments.......................................	383-87	(D)	0	(D)	(D)	(D)	(D)	(D)
Other manufacturing industries.......................	27,31,39	(D)	0	(D)	(D)	0	0	0
Nonmanufacturing industries..........................	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	3,143	853	$61	1186	(D)	20	(D)

(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of more than 50 percent.

SOURCE: National Science Foundation, SRS

Table B-13. Number of R&D-performing companies reporting Federal R&D funds by industry and size of company: 1988

Industry	SIC code	Companies with total employment of--											
		Less than 500		500 to 999		1,000 to 4,999		5,000 to 9,999		10,000 to 24,999		25,000 or more	
		Total	Federal	Total	Federal	Total	Federal	Total	Federal	Total	Federal	Total	Federal
Total............................	....	22,621	1,315	790	29	1,083	75	189	23	187	45	122	49
Food, kindred, and tobacco products...	20,21	6	0	34	0	51	0	16	0	16	1	14	0
Textiles and apparel....................	22,23	289	2	110	0	43	1	8	0	9	0	4	0
Lumber, wood products, and furniture...	24,25	78	0	28	0	38	0	6	1	5	0	1	0
Paper and allied products..............	26	259	0	13	0	32	0	10	0	11	0	3	1
Chemicals and allied products..........	28	2,326	101	38	2	72	7	9	2	23	4	7	6
Industrial chemicals.................	281-82,286	206	0	9	1	24	4	5	2	5	2	5	5
Drugs and medicines..................	283	407	101	7	1	13	3	3	0	11	2	1	1
Other chemicals......................	284-85,287-89	1,713	0	22	0	35	0	1	0	7	0	1	0
Petroleum refining and extraction......	13,29	103	0	4	0	12	1	5	2	4	2	7	4
Rubber products.........................	30	296	0	46	0	136	1	7	2	5	0	1	0
Stone, clay, and glass products........	32	88	0	28	1	28	0	6	0	6	3	2	2
Primary metals..........................	33	179	2	23	1	43	6	9	1	5	1	3	2
Ferrous metals and products..........	331-32,3398-99	80	0	10	1	20	1	7	1	3	0	2	1
Nonferrous metals and products.......	333-36	99	2	13	0	23	5	2	0	2	1	1	1
Fabricated metal products..............	34	1,938	1	58	1	60	2	9	1	12	3	0	0
Machinery...............................	35	2,548	62	106	0	135	7	23	0	12	3	7	3
Office, computing, and accounting machines............................	357	426	0	26	0	40	2	9	0	3	0	4	2
Other machinery, except electrical...	351-56,358-59	2,122	62	80	0	95	5	14	0	9	3	3	1
Electrical equipment....................	36	3,449	154	100	7	116	17	13	4	19	8	15	10
Radio and TV receiving equipment.....	365	172	0	3	0	4	0	0	0	1	0	0	0
Communication equipment..............	366	615	46	15	2	23	9	4	2	5	4	9	7
Electronic components................	367	1,275	106	36	3	38	5	5	1	6	3	3	3
Other electrical equipment...........	361-64,369	1,387	2	46	2	51	3	4	1	7	1	3	0
Transportation equipment...............	37	145	1	37	2	46	6	16	4	13	9	18	16
Motor vehicles and motor vehicles equipment............................	371	100	0	18	0	25	1	11	1	3	1	4	2
Other transportation equipment.......	373-75,379	42	0	12	0	10	0	2	1	3	2	0	0
Aircraft and missiles................	372,376	3	1	7	2	11	5	3	2	7	6	14	14

See footnotes at end of

Table B-13. Number of R&D-performing companies reporting Federal R&D funds by industry and size of company: 1988 (continued)

Industry	SIC code	Companies with total employment of--											
		Less than 500		500 to 999		1,000 to 4,999		5,000 to 9,999		10,000 to 24,999		25,000 or more	
		Total	Federal	Total	Federal	Total	Federal	Total	Federal	Total	Federal	Total	Federal
Professional and scientific instruments	38	1,817	18	42	2	50	4	6	1	5	4	5	2
Scientific and mechanical measuring instruments..........................	381-82	978	18	17	0	22	1	2	0	3	3	1	0
Optical, surgical, photographic, and other instruments....................	383-87	839	0	25	2	28	3	4	1	2	1	4	2
Other manufacturing industries..........	27,31,39	309	0	35	2	39	1	7	0	6	0	1	0
Nonmanufacturing industries............	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	8,791	974	88	11	182	22	39	5	36	7	34	3

SOURCE: National Science Foundation, SRS

Table B-14. Industry-administered federally funded R&D centers--funds by character of work, full-time-equivalent (FTE) R&D scientists and engineers, and total number of employees: 1986-88

[Dollars in millions]

Item	1986	1987	1988
Total R&D funds..........	$2,267	$2,351	$2,537
Basic research.........	124	142	107
Applied research.......	679	705	696
Development............	1,465	1,504	1,734
		January	
	1987	1988	1989
Number of FTE R&D scientists and engineers	10,453	11,624	14,113
		March	
	1986	1987	1988
Total employment.........	31,152	39,546	41,227

NOTE: Industry-administered Federally funded research and development centers centers (FFRDCs) conduct R&D almost exclusively for use by the Federal Government. Data for these FFRDCs administered by industry are included in Federal R&D support under the industry classifications of the administering firms. See section C for a listing of industry-administered FFRDCs and their locations.

SOURCE: National Science Foundation, SRS

Table B-15. Number of R&D-performing companies in manufacturing and nonmanufacturing industries by size of company: 1988

Size of company [Based on number of employees]	Number of companies reporting R&D funds		
	Total	Manu-facturing	Nonmanu-facturing
Total............................	24,992	15,821	9,171
Less than 500..........................	22,621	13,830	8,791
500 to 999.............................	790	701	89
1,000 to 4,999.........................	1083	901	182
5,000 to 9,999.........................	189	150	39
10,000 to 24,999.......................	187	151	36
25,000 or more.........................	122	88	34

SOURCE: National Science Foundation, SRS

Table B-16. Concentration of total, Federal, and company (and other) R&D funds, and net sales of R&D-performing companies: selected years

Companies ranked by size of R&D program(1)	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
					Percent of total (company, Federal, and other) R&D funds ranked by size of total R&D funds						
First 4 (1-4)	19	20	17	18	20	19	17	18	19	19	18
Next 4 (5-8)	14	13	14	12	12	11	13	12	11	12	13
Next 12 (9-20)	19	19	18	20	19	17	17	17	14	16	16
Next 20 (21-40)	13	13	13	12	13	13	13	13	13	12	12
Next 60 (41-100)	15	15	15	18	16	17	18	16	15	14	15
Next 100 (101-200)	9	9	9	9	9	9	9	9	10	8	9
Next 200 (201-400)	6	6	6	6	6	6	6	5	8	6	7
					Percent of Federal R&D funds ranked by size of Federal R&D funds						
First 4 (1-4)	(2)	(2)	(2)	(2)	(2)	(2)	30	29	30	31	31
Next 4 (5-8)	(2)	(2)	(2)	(2)	(2)	(2)	15	15	16	18	18
Next 12 (9-20)	(2)	(2)	(2)	(2)	(2)	(2)	26	27	28	27	27
Next 20 (21-40)	(2)	(2)	(2)	(2)	(2)	(2)	17	16	15	15	15
Next 60 (41-100)	(2)	(2)	(2)	(2)	(2)	(2)	10	7	7	7	7
Next 100 (101-200)	(2)	(2)	(2)	(2)	(2)	(2)	1	2	2	1	2
Next 200 (201-400)	(2)	(2)	(2)	(2)	(2)	(2)	0	0	1	0	0
					Percent of company and other (except Federal) R&D funds ranked by size of company and other R&D funds						
First 4 (1-4)	(2)	(2)	(2)	(2)	(2)	(2)	22	23	20	20	21
Next 4 (5-8)	(2)	(2)	(2)	(2)	(2)	(2)	8	7	7	7	7
Next 12 (9-20)	(2)	(2)	(2)	(2)	(2)	(2)	12	12	12	12	12
Next 20 (21-40)	(2)	(2)	(2)	(2)	(2)	(2)	12	12	10	11	12
Next 60 (41-100)	(2)	(2)	(2)	(2)	(2)	(2)	18	18	16	16	17
Next 100 (101-200)	(2)	(2)	(2)	(2)	(2)	(2)	11	10	10	10	11
Next 200 (201-400)	(2)	(2)	(2)	(2)	(2)	(2)	7	7	8	8	8
					Percent of net sales ranked by size of total R&D funds						
First 4 (1-4)	(2)	(2)	(2)	(2)	(2)	(2)	7	8	8	7	7
Next 4 (5-8)	(2)	(2)	(2)	(2)	(2)	(2)	4	4	5	5	5
Next 12 (9-20)	(2)	(2)	(2)	(2)	(2)	(2)	5	5	5	5	5
Next 20 (21-40)	(2)	(2)	(2)	(2)	(2)	(2)	8	8	7	7	7
Next 60 (41-100)	(2)	(2)	(2)	(2)	(2)	(2)	12	12	10	11	11
Next 100 (101-200)	(2)	(2)	(2)	(2)	(2)	(2)	13	13	10	8	8
Next 200 (201-400)	(2)	(2)	(2)	(2)	(2)	(2)	14	15	9	12	11

(1) Companies were ranked individually for each year; therefore, particular companies comprising the size groups may have changed from year to year.
(2) Data not collected

SOURCE: National Science Foundation, SRS

Table B-17. Domestic net sales of R&D-performing companies by industry and size of company: 1987-88

[Dollars in millions]
1987

Industry	SIC code	Total funds	Companies with total employment of--					
			Less than 500 employees	500 to 999 employees	1,000 to 4,999 employees	5,000 to 9,999 employees	10,000 to 24,999 employees	25,000 or more employees
Total		$2,282,903	$153,312	$68,277	$311,900	$212,186	$499,398	$1,037,830
Food, kindred, and tobacco products	20,21	219,393	376	4,672	28,849	20,467	46,349	118,680
Textiles and apparel	22,23	53,679	6,893	6,912	7,379	3,483	12,028	16,984
Lumber, wood products, and furniture	24,25	25,315	(D)	2,094	9,138	3,263	7,142	(D)
Paper and allied products	26	104,152	3,948	1,399	10,486	8,913	50,698	28,708
Chemicals and allied products	28	187,751	12,439	5,672	33,644	16,760	64,969	54,267
Industrial chemicals	281-82,286	83,657	1,351	1,482	10,839	9,315	19,847	40,823
Drugs and medicines	283	47,807	2,266	1,042	6,069	(D)	30,666	(D)
Other chemicals	284-85,287-89	56,288	8,823	3,148	16,736	(D)	14,456	(D)
Petroleum refining and extraction	13,29	182,068	(D)	(D)	10,778	17,806	38,283	113,052
Rubber products	30	38,572	(D)	3,398	8,903	4,687	10,463	(D)
Stone, clay, and glass products	32	38,988	1,200	2,179	7,922	3,851	10,935	12,902
Primary metals	33	80,317	2,556	2,432	14,503	13,042	24,246	23,538
Ferrous metals and products	331-32,3398-99	43,937	(D)	1,051	6,406	6,808	10,584	(D)
Nonferrous metals and products	333-36	36,380	(D)	1,381	8,097	6,234	13,662	(D)
Fabricated metal products	34	64,093	14,649	(D)	12,792	5,316	22,074	(D)
Machinery	35	152,691	27,252	9,170	37,301	14,904	15,595	48,469
Office, computing, and accounting machines	357	66,985	(D)	2,377	15,924	2,990	3,754	(D)
Other machinery, except electrical	351-56,358-59	85,706	(D)	6,793	21,377	11,914	11,841	(D)
Electrical equipment	36	195,514	18,759	5,450	23,831	12,926	40,971	93,577
Radio and TV receiving equipment	365	4,413	569	(D)	1,380	0	(D)	0
Communication equipment	366	100,805	4,338	1,007	5,691	5,678	12,623	71,468
Electronic components	367	43,434	6,986	(D)	6,763	3,839	8,474	(D)
Other electrical equipment	361-64,369	46,862	6,866	2,618	9,997	3,409	(D)	(D)
Transportation equipment	37	395,982	5,374	3,302	17,483	20,095	37,565	312,164
Motor vehicles and motor vehicles equipment	371	215,065	(D)	1,822	10,993	(D)	16,088	167,413
Other transportation equipment	373-75,379	14,584	(D)	933	3,282	(D)	7,821	0
Aircraft and missiles	372,376	166,333	(D)	547	3,208	(D)	13,656	144,751

See footnotes at end of

Table B-17. Domestic net sales of R&D-performing companies by industry and size of company: 1987-88 (continued)

[Dollars in millions]
1987
Companies with total employment of--

Industry	SIC code	Total funds	Less than 500 employees	500 to 999 employees	1,000 to 4,999 employees	5,000 to 9,999 employees	10,000 to 24,999 employees	25,000 or more employees
Professional and scientific instruments	38	$66,623	$7,461	$3,489	$9,054	$5,289	$5,937	$35,393
Scientific and mechanical measuring instruments	381-82	20,110	3,861	1,127	3,588	1,997	(D)	(D)
Optical, surgical, photographic, and other instruments	383-87	46,513	3,600	2,362	5,466	3,292	(D)	(D)
Other manufacturing industries	27,31,39	35,140	(D)	3,190	11,254	3,612	11,764	(D)
Nonmanufacturing industries	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	442,624	42,402	9,236	68,583	57,773	100,379	164,251

[Dollars in millions]
1988
Companies with total employment of--

Industry	SIC code	Total funds	Less than 500 employees	500 to 999 employees	1,000 to 4,999 employees	5,000 to 9,999 employees	10,000 to 24,999 employees	25,000 or more employees
Total	....	$2,338,884	(S)	(S)	$324,666	$225,056	$462,990	$1,103,601
Food, kindred, and tobacco products	20,21	233,213	(S)	(S)	28,627	24,225	47,908	126,982
Textiles and apparel	22,23	(S)	(S)	(S)	(S)	(S)	12,293	17,465
Lumber, wood products, and furniture	24,25	24,401	(D)	(S)	9,642	3,011	5,408	(D)
Paper and allied products	26	87,273	(S)	(S)	(S)	9,856	30,415	32,630
Chemicals and allied products	28	198,368	(S)	5,181	41,823	15,263	64,871	58,806
Industrial chemicals	281-82,286	87,327	(S)	1,536	13,483	9,380	17,135	44,597
Drugs and medicines	283	52,493	(S)	(S)	10,204	(D)	32,932	(D)
Other chemicals	284-85,287-89	58,548	(S)	2,770	18,135	(D)	14,804	(D)
Petroleum refining and extraction	13,29	182,652	(D)	(D)	(S)	16,833	40,896	112,066
Rubber products	30	39,837	(S)	(D)	9,381	5,883	9,855	(D)
Stone, clay, and glass products	32	36,936	(D)	(S)	(S)	3,984	13,721	(D)
Primary metals	33	79,029	(S)	(S)	16,351	11,908	18,525	27,423
Ferrous metals and products	331-32,3398-99	44,051	(S)	(S)	(S)	(D)	(D)	(D)
Nonferrous metals and products	333-36	34,978	(S)	(S)	10,021	(D)	(D)	(D)
Fabricated metal products	34	60,942	(S)	(S)	(S)	8,613	20,201	0

See footnotes at end of

Table B-17. Domestic net sales of R&D-performing companies by industry and size of company: 1987-88 (continued)

[Dollars in millions]
1988
Companies with total employment of--

Industry	SIC code	Total funds	Less than 500 employees	500 to 999 employees	1,000 to 4,999 employees	5,000 to 9,999 employees	10,000 to 24,999 employees	25,000 or more employees
Machinery	35	$162,189	(S)	$9,439	$37,108	$17,061	$20,266	$51,517
Office, computing, and accounting machines	357	70,266	(D)	3,134	12,034	7,705	5,050	(D)
Other machinery, except electrical	351-56,358-59	91,923	(D)	6,305	25,074	9,356	15,216	(D)
Electrical equipment	36	206,281	(S)	(S)	25,083	13,964	31,797	108,446
Radio and TV receiving equipment	365	4,537	(S)	(D)	(S)	0	(D)	0
Communication equipment	366	104,924	4,678	1,045	5,213	6,142	7,301	80,545
Electronic components	367	49,441	(S)	2,021	7,174	(S)	8,257	17,670
Other electrical equipment	361-64,369	47,379	(S)	(D)	11,454	2,804	(D)	10,231
Transportation equipment	37	406,726	(S)	(S)	16,015	21,380	29,700	331,159
Motor vehicles and motor vehicles equipment	371	225,493	(D)	(S)	10,821	(D)	6,880	185,890
Other transportation equipment	373-75,379	14,828	(D)	(S)	2,562	(D)	8,551	0
Aircraft and missiles	372,376	166,405	(D)	697	2,632	(D)	14,269	145,269
Professional and scientific instruments	38	72,256	(S)	(S)	10,326	4,543	5,943	40,857
Scientific and mechanical measuring instruments	381-82	20,441	(S)	988	4,070	1,084	(D)	(D)
Optical, surgical, photographic, and other instruments	383-87	51,815	(S)	(S)	6,256	3,459	(D)	(D)
Other manufacturing industries	27,31,39	33,062	(D)	(S)	11,364	4,039	11,051	(D)
Nonmanufacturing industries	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	460,899	(S)	(S)	(S)	59,965	100,138	176,170

(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of 50 percent of more.

SOURCE: National Science Foundation, SRS

Table B-18. Total (company, Federal, and other) R&D funds as a percent of net sales in R&D-performing manufacturing companies by industry and size of company: selected years

[Percent]

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Total....................................	....	2.9	2.6	3.0	3.1	3.8	3.9	3.9	4.4	4.7	4.6	4.8
Distribution by industry												
Food, kindred, and tobacco products(1)...............	20,21	0.4	0.4	0.4	(D)	(D)	(D)	(D)	(D)	(D)	0.6	(D)
Textiles and apparel..................................	22,23	0.4	0.4	0.4	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Lumber, wood products, and furniture................	24,25	0.7	0.7	0.8	0.8	0.8	0.8	0.7	0.8	0.6	0.6	(D)
Paper and allied products............................	26	0.9	1.0	1.0	(D)	1.1	(D)	(D)	(D)	(D)	(D)	(D)
Chemicals and allied products........................	28	3.6	3.5	3.6	3.6	4.3	4.4	4.7	5.0	5.2	5.3	5.4
Industrial chemicals...............................	281-82,286	3.5	3.2	3.3	3.2	4.0	3.9	4.0	4.4	4.6	4.7	4.5
Drugs and medicines................................	283	6.2	6.1	6.2	(D)	(D)	(D)	(D)	(D)	8.5	(D)	9.0
Other chemicals....................................	284-85,287-89	1.8	1.8	1.9	(D)	(D)	(D)	(D)	(D)	3.3	(D)	3.5
Petroleum refining and extraction....................	13,29	0.7	0.7	0.6	(D)	(D)	(D)	(D)	(D)	(D)	1.0	1.1
Rubber products..	30	1.9	1.9	2.2	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Stone, clay, and glass products......................	32	1.3	1.3	1.4	(D)	(D)	(D)	(D)	(D)	2.5	2.6	(D)
Primary metals...	33	0.7	0.6	0.7	0.9	1.1	1.3	(D)	(D)	(D)	0.9	0.8
Ferrous metals and products........................	331-32,3398-99	0.6	0.6	0.7	(D)	(D)	(D)	(D)	(D)	(D)	(D)	0.6
Nonferrous metals and products.....................	333-36	0.8	0.7	0.7	(D)	(D)	(D)	1.2	1.4	1.5	(D)	1.2
Fabricated metal products............................	34	1.1	1.1	1.4	1.4	1.3	1.4	1.5	1.5	1.5	1.5	1.6
Machinery..	35	4.6	4.5	5.0	4.9	5.6	6.2	6.4	7.6	(D)	(D)	(D)
Office, computing, and accounting machines........	357	11.1	11.0	12.0	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Other machinery, except electrical................	351-56,358-59	2.1	2.1	2.3	(D)	(D)	(D)	(D)	(D)	3.0	3.0	3.0
Electrical equipment.................................	36	5.8	6.0	6.6	6.8	7.2	7.9	6.8	7.6	7.9	8.2	8.1
Radio and TV receiving equipment..................	365	1.8	2.5	4.3	(D)	(D)	(D)	(D)	(D)	3.6	3.2	3.1
Communication equipment............................	366	7.7	8.8	9.1	9.6	11.0	11.5	9.8	10.1	9.9	10.2	9.9
Electronic components..............................	367	6.7	7.1	7.9	7.4	6.8	7.7	7.8	9.6	(D)	10.0	10.2
Other electrical equipment.........................	361-64,369	5.1	4.9	4.9	(D)	(D)	(D)	(D)	(D)	(D)	2.7	2.5
Transportation equipment.............................	37							(D)	(D)	8.3	8.7	8.9
Motor vehicles and motor vehicles equipment.......	371	3.3	3.8	4.9	4.5	4.5	4.0	3.4	3.8	(D)	(D)	(D)
Other transportation equipment....................	373-75,379	0.8	0.8	0.6	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Aircraft and missiles..............................	372,376	13.3	12.9	13.7	16.0	17.1	15.2	15.4	14.9	13.4	14.7	15.4

See footnotes at end of

Table B-18. Total (company, Federal, and other) R&D funds as a percent of net sales in R&D-performing manufacturing companies by industry and size of company: selected years (continued)

[Percent]

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Professional and scientific instruments	38	6.9	7.3	7.5	8.1	8.4	8.6	8.3	8.9	8.8	7.9	7.7
Scientific and mechanical measuring instruments	381-82	7.1	7.3	8.4	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Optical, surgical, photographic, and other instruments	383-87	6.8	7.2	6.9	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Other manufacturing industries (1)	27,31,39	0.5	0.4	0.4	(D)	(D)	(D)	(D)	(D)	1.2	(D)	(D)
Distribution by size of company [Based on number of employees]												
Less than 500		1.6	1.6	1.4	1.5	1.8	2.5	2.9	3.6	4.1	3.9	3.8
500 to 999								2.3	2.4	2.4	2.3	2.2
1,000 to 4,999		1.6	1.8	1.8	1.7	1.9	2.0	2.2	2.6	2.5	2.6	2.5
5,000 to 9,999		1.4	1.3	1.4	2.1	1.7	1.7	1.8	1.9	2.3	2.3	2.7
10,000 to 24,999		1.9	1.7	1.7	1.9	2.4	2.8	3.1	3.1	3.2	3.1	3.1
25,000 or more		4.0	3.8	4.0	4.6	5.4	5.5	5.3	6.2	6.5	6.6	6.8

(D) Data have been withheld to avoid disclosing operations of individual companies.

(1) Until 1984, tobacco products, SIC 21, was included with "other manufacturing industries."

SOURCE: National Science Foundation, SRS

Table B-19. Company and other (except Federal) R&D funds as a percent of net sales in R&D-performing manufacturing companies by industry and size of company: selected years

[Percent]

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Total....................................	....	2.0	1.9	2.1	2.2	2.6	2.6	2.6	3.0	3.2	3.1	3.2
Distribution by industry												
Food, kindred, and tobacco products(1)..............	20,21	(D)	(D)	(D)	0.4	0.4	0.4	0.4	0.6	0.6	0.6	0.5
Textiles and apparel................................	22,23	(D)	(D)	(D)	0.4	0.5	0.4	0.5	0.5	0.5	0.4	0.3
Lumber, wood products, and furniture................	24,25	0.7	0.7	0.8	0.8	0.8	0.8	0.7	0.8	0.6	0.6	0.6
Paper and allied products...........................	26	(D)	(D)	1.0	1.0	1.1	0.9	0.8	0.8	0.7	0.6	0.8
Chemicals and allied products.......................	28	3.2	3.2	3.3	3.4	4.0	4.2	4.6	4.9	5.1	5.2	5.3
Industrial chemicals..............................	281-82,286	2.9	2.6	2.8	2.8	3.5	3.4	3.8	4.2	4.4	4.4	4.3
Drugs and medicines...............................	283	(D)	(D)	6.1	6.3	7.0	7.7	8.2	8.0	8.4	8.7	9.0
Other chemicals...................................	284-85,287-89	(D)	(D)	1.9	2.1	2.3	2.5	2.9	3.1	3.3	3.3	3.5
Petroleum refining and extraction...................	13,29	0.7	0.6	0.5	0.6	0.8	0.7	0.7	0.9	1.1	1.0	1.1
Rubber products.....................................	30	(D)	(D)	(D)	1.9	1.7	1.7	1.9	1.8	1.7	1.6	1.6
Stone, clay, and glass products.....................	32	(D)	(D)	1.3	1.4	1.7	1.9	1.9	2.3	2.4	2.5	2.6
Primary metals......................................	33	0.6	0.5	0.5	0.7	0.8	0.8	0.9	0.9	1.0	0.9	0.8
Ferrous metals and products.......................	331-32,3398-99	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.5	0.7	0.6	0.6
Nonferrous metals and products....................	333-36	0.8	0.6	0.6	1.0	1.3	1.2	1.2	1.4	1.5	1.3	1.1
Fabricated metal products...........................	34	1.0	1.0	1.2	1.2	1.2	1.3	1.4	1.4	1.4	1.2	1.3
Machinery...	35	4.2	4.2	4.5	4.4	5.0	5.4	5.8	6.7	7.3	7.1	7.5
Office, computing, and accounting machines........	357	9.8	10.1	10.4	9.7	10.4	10.0	10.5	12.4	12.4	12.3	13.4
Other machinery, except electrical................	351-56,358-59	2.0	2.0	2.2	2.3	2.4	2.4	2.5	2.6	2.9	3.0	3.0
Electrical equipment................................	36	3.4	3.6	3.9	4.2	4.4	5.0	4.5	4.8	5.1	5.4	5.4
Radio and TV receiving equipment..................	365	1.4	1.7	2.7	2.6	3.3	2.9	3.7	4.3	3.6	3.2	3.1
Communication equipment...........................	366	4.5	5.0	5.4	6.0	6.7	7.2	5.1	5.4	5.2	5.5	5.5
Electronic components.............................	367	(D)	(D)	5.9	5.7	5.2	6.6	6.6	8.2	9.2	8.5	8.3
Other electrical equipment........................	361-64,369	(D)	(D)	2.5	2.8	2.3	2.6	2.2	2.0	2.2	2.6	2.5
Transportation equipment	37							3.3	3.4	3.6	3.4	3.4
Motor vehicles and motor vehicles equipment.......	371	2.9	3.2	4.2	3.9	4.0	3.5	3.0	3.1	3.3	3.4	3.4

See footnotes at end of

Table B-19. Company and other (except Federal) R&D funds as a percent of net sales in R&D-performing manufacturing companies by industry and size of company: selected years (continued)

[Percent]

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Other transportation equipment	373-75,379	(D)	(D)	0.3	0.3	0.7	1.7	2.0	2.3	2.7	2.5	2.6
Aircraft and missiles	372,376	3.2	3.5	3.8	4.6	5.1	4.1	4.0	3.9	4.0	3.6	3.5
Professional and scientific instruments	38	5.7	5.8	6.1	6.7	7.3	7.7	7.6	8.3	8.2	7.5	7.4
Scientific and mechanical measuring instruments	381-82	5.9	5.8	6.2	6.9	7.6	8.8	8.3	8.4	8.4	8.1	8.2
Optical, surgical, photographic, and other instruments	383-87	5.6	5.9	6.0	6.6	7.1	7.1	7.3	8.1	8.0	7.2	7.1
Other manufacturing industries (1)	27,31,39	0.5	0.4	0.4	0.4	0.8	1.0	1.1	1.0	1.2	1.1	1.1
Distribution by size of company [Based on number of employees]												
Less than 500		1.4	1.5	1.2	1.4	1.6	2.2	2.8	3.4	4.0	3.8	3.7
500 to 999								2.2	2.2	2.2	2.2	2.1
1,000 to 4,999		1.4	1.4	1.4	1.5	1.7	2.0	2.0	2.4	2.4	2.4	2.3
5,000 to 9,999		1.2	1.1	1.1	1.7	1.5	1.3	1.6	1.8	2.0	2.0	2.4
10,000 to 24,999		1.4	1.4	1.4	1.6	2.0	2.3	2.5	2.5	2.6	2.5	2.6
25,000 or more		2.5	2.4	2.5	2.7	3.3	3.4	3.2	3.5	3.7	3.8	3.9

(D) Data have been withheld to avoid disclosing operations of individual companies.

(1) Until 1984, tobacco products, SIC 21, was included with "other manufacturing industries."

SOURCE: National Science Foundation, SRS

Table B-20. Total (company, Federal, and other) R&D funds as a percent of net sales in R&D-performing manufacturing companies ranked by size of R&D program by industry: 1988

Industry	SIC code	Total R&D funds as a percent of net sales [Percent]			Total R&D funds [Dollars in millions]		
		First 4 companies	Next 4 companies	Next 12 companies	First 4 companies	Next 4 companies	Next 12 companies
Total		10.8	10.6	14.2	$18,099	$12,679	$16,009
Food, kindred, and tobacco products	20,21	1.3	0.9	0.4	533	207	307
Textiles and apparel	22,23	(S)	0.3	0.3	(S)	43	43
Lumber, wood products, and furniture	24,25	1.3	0.7	0.7	71	24	32
Paper and allied products	26	1.1	1.3	1.0	280	126	168
Chemicals and allied products	28	5.9	11.5	8.5	2,775	1,665	2,887
Industrial chemicals	281-82,286	6.4	4.2	3.0	2,547	507	658
Drugs and medicines	283	11.5	10.6	9.0	1,665	1,103	1,742
Other chemicals	284-85,287-89	5.5	8.6	2.5	1,150	281	318
Petroleum refining and extraction	13,29	1.5	0.8	0.7	1,189	485	265
Rubber products	30	3.5	1.8	1.8	405	66	101
Stone, clay, and glass products	32	5.2	1.6	1.1	753	101	74
Primary metals	33	0.8	1.2	1.0	236	100	178
Ferrous metals and products	331-32,3398-99	0.5	0.9	1.3	114	62	71
Nonferrous metals and products	333-36	1.7	1.2	0.9	221	73	82
Fabricated metal products	34	6.1	2.7	1.5	398	153	172
Machinery	35	17.6	14.7	10.1	7,680	1,029	1,698
Office, computing, and accounting machines	357	19.4	15.8	12.2	7,660	867	1,288
Other machinery, except electrical	351-56,358-59	6.2	5.9	5.1	881	270	439
Electrical equipment	36	11.4	12.4	10.9	6,946	2,632	3,198
Radio and TV receiving equipment	365	(D)	10.8	(S)	(D)	13	(S)
Communication equipment	366	11.4	13.2	7.5	6,946	1,548	1,399
Electronic components	367	12.9	16.0	12.4	2,497	886	862
Other electrical equipment	361-64,369	5.5	2.2	1.6	388	134	209
Transportation equipment	37	10.0	11.5	10.0	15,912	10,255	8,530
Motor vehicles and motor vehicles equipment	371	(D)	1.1	0.8	(D)	168	134
Other transportation equipment	373-75,379	4.9	(S)	(S)	480	(S)	(S)
Aircraft and missiles	372,376	18.0	20.2	11.3	13,087	7,063	5,248

See footnotes at end of

Table B-20. Total (company, Federal, and other) R&D funds as a percent of net sales in R&D-performing manufacturing companies ranked by size of R&D program by industry: 1988 (continued)

Industry	SIC code	Total R&D funds as a percent of net sales [Percent]			Total R&D funds [Dollars in millions]		
		First 4 companies	Next 4 companies	Next 12 companies	First 4 companies	Next 4 companies	Next 12 companies
Professional and scientific instruments..............	38	9.4	8.2	8.4	3,277	758	504
Scientific and mechanical measuring instruments....	381-82	(D)	10.1	4.9	(D)	91	162
Optical, surgical, photographic, and other instruments..	383-87	7.7	12.7	8.2	2,627	578	283
Other manufacturing industries........................	27,31,39	2.5	2.2	1.1	157	78	71

NOTE: Rankings were based on total (company, Federal, and other) R&D funds.

(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of more than 50 percent.

SOURCE: National Science Foundation, SRS

Table B-21. Company and other (except Federal) R&D funds as a percent of net sales in R&D-performing manufacturing companies ranked by size of company-financed R&D program by industry: 1988

Industry	SIC code	Company and other R&D funds as a percent of net sales [Percent]			Company and other R&D funds [Dollars in millions]		
		First 4 companies	Next 4 companies	Next 12 companies	First 4 companies	Next 4 companies	Next 12 companies
Total		6.4	8.1	5.5	$13,613	$4,488	$8,148
Food, kindred, and tobacco products	20,21	1.3	0.9	0.4	533	207	306
Textiles and apparel	22,23	(S)	0.3	(S)	(S)	42	(S)
Lumber, wood products, and furniture	24,25	1.3	0.7	0.7	71	24	32
Paper and allied products	26	1.1	1.3	1.0	280	126	168
Chemicals and allied products	28	5.6	11.5	8.4	2,638	1,664	2,883
Industrial chemicals	281-82,286	6.0	3.1	3.6	2,406	502	625
Drugs and medicines	283	11.5	10.5	9.0	1,664	1,103	1,742
Other chemicals	284-85,287-89	5.5	8.6	2.5	1,150	281	318
Petroleum refining and extraction	13,29	1.5	0.8	1.0	1,186	480	255
Rubber products	30	3.5	1.8	1.6	405	57	97
Stone, clay, and glass products	32	5.1	1.6	(S)	738	101	(S)
Primary metals	33	0.8	1.1	1.0	232	95	168
Ferrous metals and products	331-32,3398-99	0.5	0.9	1.3	114	62	71
Nonferrous metals and products	333-36	1.6	1.2	0.9	213	64	81
Fabricated metal products	34	5.1	2.1	1.4	311	120	167
Machinery	35	14.4	(S)	9.9	6,315	(S)	1,680
Office, computing, and accounting machines	357	16.0	15.8	12.2	6,303	867	1,282
Other machinery, except electrical	351-56,358-59	6.0	5.9	5.0	860	270	432
Electrical equipment	36	8.9	7.3	5.0	4,441	1,205	2,192
Radio and TV receiving equipment	365	(D)	10.8	(S)	(D)	13	(S)
Communication equipment	366	7.4	3.4	4.8	3,860	833	660
Electronic components	367	12.5	7.9	11.6	1,786	830	805
Other electrical equipment	361-64,369	5.4	2.2	1.6	386	134	209
Transportation equipment	37	4.2	3.8	3.5	8,781	2,486	2,006
Motor vehicles and motor vehicles equipment	371	4.0	1.0	0.7	7,477	127	121
Other transportation equipment	373-75,379	3.4	(S)	(S)	339	(S)	(S)
Aircraft and missiles	372,376	4.3	4.4	2.0	3,440	1,447	839

See footnotes at end of

Table B-21. Company and other (except Federal) R&D funds as a percent of net sales in R&D-performing manufacturing companies ranked by size of company-financed R&D program by industry: 1988 (continued)

Industry	SIC code	Company and other R&D funds as a percent of net sales [Percent]			Company and other R&D funds [Dollars in millions]		
		First 4 companies	Next 4 companies	Next 12 companies	First 4 companies	Next 4 companies	Next 12 companies
Professional and scientific instruments......	38	9.1	6.9	8.9	3,192	682	475
Scientific and mechanical measuring instruments..................................	381-82	(D)	10.1	4.1	(D)	91	150
Optical, surgical, photographic, and other instruments...........................	383-87	7.5	10.5	8.2	2,542	478	283
Other manufacturing industries...............	27,31,39	2.5	2.2	1.1	157	78	71

NOTE: Rankings were based on comapny and other (except Federal) R&D funds.

(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of 50 percent or more.

SOURCE: National Science Foundation, SRS

Table B-22. Total (company, Federal, and other) funds for industrial energy R&D performance by industry: selected years and projected 1989

[Dollars in millions]

Industry	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Projected 1989
Total		$2,965	$3,643	$4,162	$4,216	$4,240	$4,345	$4,446	$3,954	$3,358	$3,576	$3,753	$3,810
Food, kindred, and tobacco products(1)	20,21	(2)	(2)	4	5	(2)	(2)	(S)	2	2	(S)	(3)	(D)
Textiles and apparel	22,23	(2)	(2)	(2)	(2)	(2)	(2)	2	1	(D)	(D)	(D)	(D)
Lumber, wood products, and furniture	24,25	(2)	(2)	3	4	5	5	5	3	(D)	(D)	(D)	(D)
Paper and allied products	26	2	3	3	2	3	3	6	(D)	(D)	1	1	1
Chemicals and allied products	28	157	220	257	312	347	345	191	162	(S)	(S)	(S)	(D)
Industrial chemicals	281-82,286	(2)	(2)	246	305	338	335	181	(D)	(D)	(D)	(D)	(S)
Drugs and medicines	283	(2)	(2)	(2)	(2)	(2)	(2)	(D)	(D)	(D)	(D)	(D)	(D)
Other chemicals	284-85,287-89	(2)	(2)	(2)	(2)	(2)	(2)	(D)	2	2	2	4	4
Petroleum refining and extraction	13,29	648	776	845	1,067	1,162	1,284	1,356	1,199	999	914	990	952
Rubber products	30	12	12	15	17	14	17	16	(D)	(D)	(D)	(D)	(D)
Stone, clay, and glass products	32	7	17	21	24	17	7	5	(D)	(D)	1	(D)	(D)
Primary metals	33	49	72	78	80	101	92	(S)	(S)	74	18	21	(D)
Ferrous metals and products	331-32,3398-99	14	19	20	20	22	35	35	26	(D)	(D)	(D)	(D)
Nonferrous metals and products	333-36	33	48	58	59	79	57	(S)	(S)	(D)	(D)	(D)	(D)
Fabricated metal products	34	(2)	(2)	(2)	(2)	54	31	(D)	8	(D)	(D)	(D)	(D)
Machinery	35	80	83	108	127	183	163	201	240	261	(D)	240	(D)
Office, computing, and accounting machines	357	(2)	13	17	6	16	(2)	(S)	12	(D)	(D)	(D)	(D)
Other machinery, except electrical	351-56,358-59	(2)	70	91	121	167	144	179	228	(D)	(D)	(D)	247
Electrical equipment	36	714	843	917	908	831	813	752	733	(D)	578	744	882
Radio and TV receiving equipment	365	0	0	3	(2)	5	0	0	0	0	0	0	0
Communication equipment	366	(2)	(2)	(2)	(2)	155	150	(D)	115	(D)	(D)	(D)	(D)
Electronic components	367	5	13	12	15	40	82	(D)	(D)	(D)	(D)	(D)	(D)
Other electrical equipment	361-64,369	(2)	(2)	(2)	(2)	631	581	618	(D)	(D)	(S)	(D)	(D)
Transportation equipment	37							(D)	(S)	(S)	(S)	(D)	947
Motor vehicles and motor vehicles equipment	371	(2)	(2)	(2)	(2)	(2)	(2)	(D)	(D)	(D)	(D)	(D)	(D)
Other transportation equipment	373-75,379	(2)	(2)	(2)	(2)	2	2	1	(D)	(D)	(D)	(D)	(D)
Aircraft and missiles	372,376	283	372	446	412	363	425	661	681	537	754	707	694

See footnotes at end of

Table B-22. Total (company, Federal, and other) funds for industrial energy R&D performance by industry: selected years and projected 1989 (continued)

[Dollars in millions]

Industry	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Projected 1989
Professional and scientific instruments............	38	27	28	45	53	54	45	36	(D)	(D)	17	16	17
Scientific and mechanical measuring instruments..	381-82	19	24	40	(2)	(2)	(2)	(D)	(D)	(D)	(D)	(D)	(D)
Optical, surgical, photographic, and other instruments....................................	383-87	8	4	5	(2)	(2)	(2)	(D)	(D)	0	(D)	(D)	(D)
Other manufacturing industries (1).................	27,31,39	7	7	19	(2)	12	17	12	0	0	0	0	0
Nonmanufacturing industries........................	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	220	324	333	374	375	349	424	338	328	433	512	669

(1) Until 1984, tobacco products, SIC 21, was included with "other manufacturing industries."
(2) Not separately available but included in total. See general notes.
(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of more than 50 percent.

SOURCE: National Science Foundation, SRS

Table B-23. Company and other (except Federal) funds for industrial energy R&D performance by selected industry: selected years and projected 1989

[Dollars in millions]

Industry	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Projected 1989
Total		$1,796	$2,230	$2,599	$2,680	$2,762	$2,842	$2,962	$2,537	$2,167	$2,410	$2,368	$2,207
Chemicals and allied products	28	(1)	(1)	(1)	149	178	166	169	(D)	(D)	(D)	(D)	(S)
Petroleum refining and extraction	13,29	530	623	699	957	1,096	1,218	(D)	1,145	957	911	984	944
Machinery	35	(1)	(1)	(1)	(1)	(1)	(1)	(D)	(D)	(D)	(D)	(D)	239
Electrical equipment	36	137	219	205	203	146	132	123	71	(D)	(D)	(D)	(D)
Aircraft and missiles	372,376	68	113	163	124	99	(1)	190	264	236	(D)	261	244
All other manufacturing industries		(1)	(1)	(1)	1,053	1,079	(1)	779	610	497	564	478	310
Nonmanufacturing industries	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	82	141	154	194	164	143	189	84	(D)	170	(S)	227

(1) Not separately available but included in total. See general notes.
(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of more than 50 percent.

SOURCE: National Science Foundation, SRS

Table B-24. Federal funds for industrial energy R&D performance by selected industry: selected years and projected 1989

[Dollars in millions]

Industry	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Projected 1989
Total		$1,169	$1,413	$1,563	$1,536	$1,478	$1,503	$1,484	$1,417	$1,191	$1,166	$1,385	$1,603
Chemicals and allied products	28	(1)	(1)	(1)	163	169	179	22	(D)	(D)	(D)	(D)	(D)
Petroleum refining and extraction	13,29	118	153	146	110	66	66	(D)	54	42	3	6	8
Machinery	35	(1)	(1)	(1)	(1)	(1)	(1)	(D)	(D)	(D)	(D)	(D)	(D)
Electrical equipment	36	577	624	711	705	685	681	629	662	(D)	(D)	(D)	(D)
Aircraft and missiles	372,376	215	259	283	288	264	(1)	471	417	302	(D)	447	450
All other manufacturing industries		(1)	(1)	(1)	90	83	(1)	52	13	4	5	(D)	(D)
Nonmanufacturing industries	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	139	183	179	180	211	206	235	254	(D)	263	(S)	(S)

(1) Not separately available but included in total. See general notes.
(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of more than 50 percent.

SOURCE: National Science Foundation, SRS

Table B-25. Total (company, Federal, and other) funds for industrial energy R&D performance by primary energy source: selected years and projected 1989

[Dollars in millions]

Primary energy source	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Projected 1989
Total.........	$2,965	$3,643	$4,162	$4,216	$4,240	$4,345	$4,446	$3,954	$3,358	$3,576	$3,753	$3,810
Fossil fuels........	843	1,063	1,228	1,437	1,491	1,573	1,738	1,876	1,476	1,548	1,607	1,416
Oil................	(1)	557	(1)	772	(1)	905	(1)	1,395	(1)	(S)	(1)	(1)
Gas................	(1)	113	(1)	208	(1)	255	(1)	189	(1)	191	(1)	(1)
Shale..............	(1)	24	(1)	57	(1)	48	(1)	125	(1)	11	(1)	(1)
Coal...............	(1)	313	(1)	383	(1)	(2)	(1)	150	(1)	46	(1)	(1)
Synthetic fossil fuels..........	(1)	236	(1)	210	(1)	(2)	(1)	111	(1)	23	(1)	(1)
Mining..........	(1)	1	(1)	31	(1)	(2)	(1)	8	(1)	3	(1)	(1)
Other...........	(1)	76	(1)	142	(1)	(2)	(1)	31	(1)	(S)	(1)	(1)
Other fossil fuels	(1)	56	(1)	17	(1)	(2)	(1)	17	(1)	51	(1)	(1)
Nuclear.............	995	1,037	1,056	1,037	1,078	1,118	1,113	1,212	979	926	1,119	1,248
Fission...........	(1)	913	(1)	866	(1)	973	(1)	1,062	(1)	859	(1)	(1)
Fusion............	(1)	124	(1)	171	(1)	145	(1)	150	(1)	(S)	(1)	(1)
Total geothermal, solar, conservation, and utilization....	(1)	1,156	(1)	774	(1)	1,424	1,218	471	504	421	497	562
Geothermal........	(1)	149	(1)	71	(1)	(2)	(1)	54	(1)	48	(1)	(1)
Solar.............	(1)	321	(1)	298	(1)	(2)	(1)	96	(1)	95	(1)	(1)
Conservation and utilization......	(1)	686	(1)	405	(1)	(2)	(1)	321	(1)	281	(1)	(1)
All other energy....	(1)	387	(1)	968	(1)	230	377	395	399	(S)	530	584

(S) Data have been withheld due to imputation of more than 50 percent
(1) Data not collected.
(2) Not separately available, but included in total. See general notes.

NOTE: Detailed data for 1979, 1981, 1983, 1985, and 1987 were estimated on the basis of (a) data actually reported in those years, (b) revised data for those years reported on the 1978, 1980, 1982, 1984, 1986, and 1988 survey forms, and (c) adjustments due to new samples in 1981 and 1987.

SOURCE: National Science Foundation, SRS

Table B-26. Company and other (except Federal) funds for industrial energy R&D performance by primary energy source: selected years and projected 1989

[Dollars in millions]

Primary energy source	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Projected 1989
Total	$1,796	$2,230	$2,599	$2,680	$2,762	$2,842	$2,962	$2,537	$2,167	$2,410	$2,368	$2,207
Fossil fuels	678	788	993	1,257	1,361	1,455	1,509	1,797	(D)	(D)	1,544	1,321
Oil	(1)	529	(1)	746	(1)	(2)	(1)	1,381	(1)	(S)	(1)	(1)
Gas	(1)	109	(1)	(2)	(1)	(2)	(1)	(D)	(1)	(S)	(1)	(1)
Shale	(1)	(2)	(1)	(2)	(1)	(2)	(1)	124	(1)	(S)	(1)	(1)
Coal	(1)	130	(1)	244	(1)	(2)	(1)	(S)	(1)	29	(1)	(1)
Synthetic fossil fuels	(1)	84	(1)	132	(1)	(2)	(1)	91	(1)	(S)	(1)	(1)
Mining	(1)	1	(1)	24	(1)	(2)	(1)	8	(1)	(D)	(1)	(1)
Other	(1)	45	(1)	89	(1)	(2)	(1)	(S)	(1)	(D)	(1)	(1)
Other fossil fuels	(1)	(2)	(1)	(2)	(1)	(2)	(1)	17	(1)	(S)	(1)	(1)
Nuclear	217	169	150	126	99	90	101	150	91	109	140	122
Fission	(1)	167	(1)	70	(1)	71	(1)	135	(1)	82	(1)	(1)
Fusion	(1)	2	(1)	56	(1)	19	(1)	15	(1)	(S)	(1)	(1)
Total geothermal, solar, conservation, and utilization	(1)	1,054	(1)	573	(1)	1,147	1,086	313	(D)	(D)	318	365
Geothermal	(1)	122	(1)	40	(1)	(2)	(1)	27	(1)	(D)	(1)	(1)
Solar	(1)	251	(1)	199	(1)	(2)	(1)	51	(1)	41	(1)	(1)
Conservation and utilization	(1)	681	(1)	334	(1)	(2)	(1)	235	(1)	(D)	(1)	(1)
All other energy	(1)	219	(1)	724	(1)	150	267	277	(D)	(D)	366	399

(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of more than 50 percent.
(1) Data not collected.
(2) Not separately available but included in total. See general notes.

NOTE: Detailed data for 1979, 1981, 1983, 1985, and 1987 were estimated on the basis of (a) data actually reported in those years, (b) revised data for those years reported on the 1978, 1980, 1982, 1984, 1986, and 1988, and (c) adjustments due to new samples in 1981 and 1987.

SOURCE: National Science Foundation, SRS

Table 3-27. Federal funds for industrial energy R&D performance by primary energy source: selected years and projected 1989

[Dollars in millions]

Primary energy source	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Projected 1989
Total..................	$1,169	$1,413	$1,563	$1,536	$1,478	$1,503	$1,484	$1,417	$1,191	$1,166	$1,385	$1,603
Fossil fuels.................	165	275	235	180	130	117	228	78	(D)	(D)	63	95
Oil.........................	(1)	29	(1)	26	(1)	(2)	(1)	13	(1)	(S)	(1)	(1)
Gas.........................	(1)	4	(1)	(2)	(1)	10	(1)	(D)	(1)	(D)	(1)	(1)
Shale.......................	(1)	(2)	(1)	(2)	(1)	1	(1)	1	(1)	(D)	(1)	(1)
Coal........................	(1)	183	(1)	139	(1)	76	(1)	(S)	(1)	17	(1)	(1)
Synthetic fossil fuels...	(1)	152	(1)	78	(1)	(2)	(1)	20	(1)	8	(1)	(1)
Mining....................	(1)	0	(1)	7	(1)	(2)	(1)	0	(1)	(D)	(1)	(1)
Other.....................	(1)	31	(1)	53	(1)	(2)	(1)	(S)	(1)	(D)	(1)	(1)
Other fossil fuels.........	(1)	(2)	(1)	(2)	(1)	16	(1)	0	(1)	1	(1)	(1)
Nuclear......................	778	868	906	911	979	1,029	1,013	1,063	888	817	979	1,126
Fission.....................	(1)	746	(1)	796	(1)	902	(1)	928	(1)	777	(1)	(1)
Fusion......................	(1)	122	(1)	115	(1)	127	(1)	135	(1)	(S)	(1)	(1)
Total geothermal, solar. conservation, and utilization.............	(1)	102	(1)	201	(1)	277	132	158	(D)	(D)	179	197
Geothermal.................	(1)	27	(1)	31	(1)	(2)	(1)	26	(1)	(D)	(1)	(1)
Solar.......................	(1)	70	(1)	99	(1)	(2)	(1)	45	(1)	37	(1)	(1)
Conservation and utilization...............	(1)	5	(1)	71	(1)	80	(1)	87	(1)	(D)	(1)	(1)
All other energy.............	(1)	168	(1)	244	(1)	80	110	118	(D)	(D)	164	185

(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of more than 50 percent.
(1) Data not collected.
(2) Not separately available but included in total. See general notes.

NOTE: Detailed data for 1979, 1981, 1983, 1985, and 1987 were estimated on the basis of (a) data actually reported in those years, (b) revised data for those years reported on the 1978, 1980, 1982, 1984, 1986, and 1988 survey forms, and (c) adjustments due to new samples in 1981 and 1987.

SOURCE: National Science Foundation, SRS

Table B-28. Total (company, Federal, and other) funds for industrial pollution-abatement R&D performance by industry: selected years and projected 1989

[Dollars in millions]

Industry	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Projected 1989
Total		$1,065	$1,249	$1,202	(S)	(S)	(S)	$1,060	(S)	(S)	(S)	(S)	(S)
Food, kindred, and tobacco products(1)	20,21	2	2	3	1	1	9	12	1	1	1	1	2
Textiles and apparel	22,23	(2)	(2)	(2)	(2)	(2)	(2)	(S)	(3)	(D)	(3)	(S)	(S)
Lumber, wood products, and furniture	24,25	3	3	4	5	3	2	(D)	1	(D)	(D)	(D)	(D)
Paper and allied products	26	8	(2)	(2)	(2)	9	6	7	8	7	7	9	10
Chemicals and allied products	28	79	146	178	186	191	167	158	(S)	168	117	136	128
Industrial chemicals	281-82,286	67	128	157	165	173	144	140	(S)	(S)	(D)	117	112
Drugs and medicines	283	(2)	4	4	6	6	11	8	(D)	(D)	(D)	(D)	(D)
Other chemicals	284-85,287-89	(2)	13	16	15	12	12	10	14	(D)	12	(D)	(D)
Petroleum refining and extraction	13,29	71	80	95	92	97	81	88	60	63	51	60	66
Rubber products	30	3	3	3	(2)	2	1	(D)	(D)	(D)	(D)	(S)	(S)
Stone, clay, and glass products	32	7	9	11	9	7	9	(S)	3	4	(D)	(D)	(D)
Primary metals	33	25	29	30	24	22	21	21	20	8	5	8	9
Ferrous metals and products	331-32,3398-99	13	14	14	15	13	10	13	11	2	(D)	(D)	(D)
Nonferrous metals and products	333-36	12	15	15	9	9	11	8	9	6	(D)	(D)	(D)
Fabricated metal products	34	(2)	6	7	3	11	7	14	6	(D)	(D)	(D)	(D)
Machinery	35	38	31	30	34	30	27	26	26	33	38	46	60
Office, computing, and accounting machines	357	0	0	1	0	0	0	(D)	0	0	0	0	0
Other machinery, except electrical	351-56,358-59	37	30	29	34	30	27	(D)	26	33	38	46	60
Electrical equipment	36	19	34	39	39	24	18	(D)	(D)	5	(D)	(D)	(D)
Radio and TV receiving equipment	365	0	0	0	0	0	0	0	0	0	0	0	0
Communication equipment	366	6	5	6	(2)	(2)	(2)	(D)	1	1	(D)	(D)	(D)
Electronic components	367	(2)	(2)	(2)	(2)	(2)	(2)	(S)	(3)	(D)	(D)	0	(D)
Other electrical equipment	361-64,369	(2)	(2)	(2)	(2)	(2)	12	(D)	(D)	(D)	(D)	(D)	(D)
Transportation equipment	37							(S)	(S)	(S)	(S)	(S)	(S)
Motor vehicles & motor vehicles equipment	371	593	(2)	(2)	(2)	(2)	(2)	(D)	(D)	(D)	(D)	(D)	(D)
Other transportation equipment	373-75,379	(2)	0	(2)	0	0	(2)	(D)	(D)	(D)	(D)	(D)	(D)
Aircraft and missiles	372,376	64	64	38	30	(2)	(2)	(D)	(S)	87	123	103	113

See footnotes at end of

Table B-28. Total (company, Federal, and other) funds for industrial pollution-abatement R&D performance by industry: selected years and projected 1989 (continued)

[Dollars in millions]

Industry	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Projected 1989
Professional and scientific instruments.....	38	4	3	(2)	(2)	(2)	3	2	2	(D)	(D)	(D)	(D)
Scientific and mechanical measuring instruments..............................	381-82	(2)	(2)	(2)	(2)	(2)	1	(D)	(D)	(D)	(D)	(D)	(D)
Optical, surgical, photographic, and other instruments..............................	383-87	(2)	(2)	(2)	(2)	(2)	2	(D)	(D)	(D)	(D)	(D)	(D)
Other manufacturing industries..............	27,31,39	3	2	3	(2)	(2)	2	3	(S)	0	(D)	(D)	(D)
Nonmanufacturing industries.................	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	102	104	79	77	65	124	113	118	80	113	90	(S)

(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of more than 50 percent.
(1) Until 1984, tobacco products, SIC 21, was included with "other manufacturing industries."
(2) Not separately available but included in total. See general notes.
(3) Less than $0.5 million.

SOURCE: National Science Foundation, SRS

Table B-29. Company and other (except Federal) funds for industrial pollution-abatement R&D performance by selected industry: selected years and projected 1989

[Dollars in millions]

Industry	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Projected 1989
Total	....	(1)	$1,139	$1,095	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)
Chemicals and allied products	28	(1)	113	130	128	123	101	(D)	(S)	(D)	(D)	(D)	(D)
Petroleum refining and extraction	13,29	(1)	(2)	93	92	97	82	(D)	61	63	51	60	66
Machinery	35							(D)	(D)	33	38	46	60
Electrical equipment	36	(1)	17	19	19	12	13	(D)	(D)	(D)	(D)	(D)	(D)
Aircraft and missiles	372,376	(1)	(2)	26	20	22	17	24	(D)	(D)	62	(D)	(D)
All other manufacturing industries	....	(1)	(2)	705	(2)	(2)	(2)	565	(D)	676	(D)	(D)	(D)
Nonmanufacturing industries	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	(1)	98	63	39	38	51	47	(D)	(D)	(D)	(D)	(D)

(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of 50 percent or more.
(1) Data not available for 1978.
(2) Not separately available but included in total. See general notes.

SOURCE: National Science Foundation, SRS

Table B-30. Federal funds for industrial pollution-abatement R&D performance by selected industry: selected years and projected 1989

[Dollars in millions]

Industry	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Projected 1989
Total	....	(1)	$98	$107	$129	$122	$176	$169	$169	$148	$186	$175	$176
Chemicals and allied products	28	(1)	36	48	58	68	66	(D)	(D)	(D)	(D)	(D)	(D)
Petroleum refining and extraction	13,29	(1)	(2)	2	0	0	0	(D)	0	0	0	0	0
Machinery	35							(D)	(D)	0	0	0	0
Electrical equipment	36	(1)	17	20	20	12	5	(D)	(D)	(D)	(D)	(D)	(D)
Aircraft and missiles	372,376	(1)	(2)	12	10	(2)	(2)	(D)	(D)	(D)	61	(D)	(D)
All other manufacturing industries	....	(1)	(2)	6	3	(2)	(2)	(D)	(D)	(D)	(D)	0	0
Nonmanufacturing industries	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	(1)	15	16	38	26	74	67	(D)	(D)	(D)	(D)	(D)

(D) Data have been withheld to avoid disclosing information about individual companies.
(1) Data not available for 1978.
(2) Not separately available but included in total. See general notes.

SOURCE: National Science Foundation, SRS

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Table B-31. Number of full-time-equivalent (FTE) R&D scientists and engineers by industry and size of company: selected years

[In thousands]

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Total (January)		404.4	423.9	450.6	487.8	509.8	540.9	584.1	622.5	671.0	697.3	708.6	724.9
Total (Annual Average)		414.2	437.3	469.2	498.8	525.4	562.5	603.3	646.8	684.2	703.0	716.8	N/A
Distribution by industry													
Food, kindred, and tobacco products(1)	20,21	6.9	7.4	7.2	7.4	7.4	7.7	7.4	(S)	(S)	(S)	(S)	(S)
Textiles and apparel	22,23	1.8	1.8	(2)	2.0	1.9	2.2	2.3	2.8	2.6	2.5	2.4	(S)
Lumber, wood products, and furniture	24,25	2.0	1.8	1.7	1.6	(2)	1.8	(2)	(S)	(S)	(S)	1.3	(S)
Paper and allied products	26	6.5	7.1	7.4	8.0	8.4	7.6	6.6	6.6	6.4	5.8	6.1	(S)
Chemicals and allied products	28	48.3	50.0	51.4	54.7	61.6	67.3	69.8	71.1	75.8	73.0	75.8	77.4
Industrial chemicals	281-82,286	21.3	21.4	20.9	21.6	25.9	26.6	25.6	23.5	24.9	24.4	(S)	(S)
Drugs and medicines	283	19.5	20.8	21.6	23.3	25.6	28.2	(2)	30.8	31.8	29.1	33.0	33.9
Other chemicals	284-85,287-89	7.5	7.8	8.9	9.8	10.1	12.1	13.4	16.7	19.1	19.5	20.3	(S)
Petroleum refining and extraction	13,29	9.9	10.1	10.8	13.0	15.6	14.7	13.3	13.5	10.4	8.6	9.5	10.0
Rubber products	30	7.9	8.1	(2)	10.3	8.1	(2)	(2)	(S)	(S)	(S)	(S)	(S)
Stone, clay, and glass products	32	5.1	5.2	5.4	5.6	5.1	5.5	5.6	6.6	7.5	8.6	8.6	8.3
Primary metals	33	8.1	7.9	8.1	7.9	8.4	8.3	8.4	7.1	5.7	6.0	5.6	5.6
Ferrous metals and products	331-32,3398-99	4.2	4.3	4.7	4.8	5.2	5.2	5.3	4.2	2.5	2.6	2.3	(S)
Nonferrous metals and products	333-36	3.9	3.6	3.4	3.1	3.2	3.0	3.1	2.9	3.2	3.4	3.3	3.4
Fabricated metal products	34	7.0	6.8	7.8	7.8	8.2	(2)	16.6	(S)	(S)	(S)	10.5	(S)
Machinery	35	57.8	60.2	62.1	69.2	76.0	79.6	87.0	81.7	89.7	96.4	98.4	99.7
Office, computing, and accounting machines	357	38.9	40.9	41.8	43.7	48.1	52.6	56.5	61.8	71.9	73.8	74.4	76.4
Other machinery, except electrical	351-56,358-59	18.9	19.3	20.3	25.5	27.9	27.0	30.5	19.9	17.8	22.6	24.0	23.3
Electrical equipment	36	84.4	85.0	94.5	106.9	109.8	108.6	113.2	113.2	117.9	128.3	132.5	139.9
Radio and TV receiving equipment	365	1.5	2.1	4.0	7.9	7.8	(2)	(2)	(S)	1.8	1.4	1.3	1.3
Communication equipment	366	39.0	40.4	42.4	44.2	45.9	48.8	59.3	62.2	65.0	73.3	73.1	75.5
Electronic components	367	14.2	14.0	18.1	22.8	24.4	25.6	(2)	29.2	(S)	40.2	44.3	(S)
Other electrical equipment	361-64,369	29.7	28.5	30.0	32.0	31.7	(2)	18.4	17.9	16.5	13.5	(S)	(S)
Transportation equipment	37	115.8	123.7	125.6	131.7	122.3	134.3	(2)	160.3	179.2	184.8	188.2	192.8
Motor vehicles and motor vehicles equipment	371	31.9	35.2	38.2	35.1	30.0	29.0	28.6	28.7	33.9	50.2	47.3	45.9
Other transportation equipment	373-75,379	1.9	2.0	1.5	1.4	1.2	2.2	(2)	(S)	(S)	(S)	(S)	(S)
Aircraft and missiles	372,376	82.0	86.5	85.9	95.2	91.1	103.1	111.5	130.2	144.8	130.1	136.4	142.1

See footnotes at end of

Table B-31. Number of full-time-equivalent (FTE) R&D scientists and engineers by industry and size of company: selected years (continued)

[In thousands]

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Professional and scientific instruments..............	38	23.3	27.0	32.8	34.7	42.7	(2)	(2)	(S)	(S)	(S)	(S)	(S)
Scientific and mechanical measuring instruments....	381-82	9.0	11.7	(2)	18.6	(2)	(2)	(2)	(S)	(S)	(S)	(S)	(S)
Optical, surgical, photographic, and other instruments......................................	383-87	14.3	15.3	16.3	16.0	16.1	(2)	(2)	19.8	24.0	26.2	24.9	(S)
Other manufacturing industries.......................	27,31,39	4.6	4.7	4.6	4.8	5.5	5.9	(2)	(S)	(S)	(S)	6.4	(S)
Nonmanufacturing industries..........................	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	15.0	17.1	19.8	22.2	27.1	31.2	49.8	66.8	75.1	88.6	101.9	(S)
Distribution by size of company [Based on number of employees]													
Less than 500......................................	....	29.5	30.5	34.4	38.0	40.7	52.7	81.9	78.3	(S)	105.9	109.0	(S)
500 to 999...	....								16.5	(S)	21.6	19.3	18.0
1,000 to 4,999.....................................	....	27.5	30.9	34.8	38.9	42.8	48.3	52.6	61.6	66.7	73.7	81.9	80.3
5,000 to 9,999.....................................	....	28.7	30.7	29.6	27.2	36.6	29.8	30.1	28.5	38.9	39.5	40.2	47.5
10,000 to 24,999...................................	....	52.1	55.6	64.4	71.8	77.0	84.3	84.0	89.9	88.4	83.2	94.5	86.1
25,000 or more.....................................	....	266.6	276.2	287.4	311.8	312.7	325.8	335.5	347.6	365.3	373.4	365.2	380.1

(S) Data have been withheld due to imputation of 50 percent or more.
(1) Until 1984, tobacco products (SIC 21) was included with "other manufacturing industries."
(2) Not separately available but included in total. See general notes.
(3) Data included in the other manufacturing industries group.

N/A Not available

SOURCE: National Science Foundation, SRS

Table B-32. Cost per R&D scientist or engineer by industry: selected years

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Total		$80,400	$87,400	$94,900	$103,900	$111,600	$116,000	$124,000	$130,200	$128,900	$133,900	$138,700
Distribution by industry												
Food, kindred, and tobacco products(1)	20,21	66,000	72,300	84,900	(D)	(D)	(D)	(D)	(D)	(D)	(S)	(D)
Textiles and apparel	22,23	49,400	53,200	57,500	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Lumber, wood products, and furniture	24,25	66,300	79,400	89,700	(S)	(S)	(S)	115,400	116,300	(S)	(S)	(D)
Paper and allied products	26	56,900	61,400	64,300	(D)	70,800	(D)	(D)	(D)	(D)	(D)	(D)
Chemicals and allied products	28	72,800	79,600	87,400	96,600	102,500	104,800	112,500	116,300	118,900	132,800	140,600
Industrial chemicals	281-82,286	84,200	92,800	103,400	118,000	122,100	123,100	132,000	144,600	144,100	(S)	(S)
Drugs and medicines	283	64,800	71,400	79,200	(D)	(D)	103,100	(D)	(D)	120,100	(D)	141,500
Other chemicals	284-85,287-89	61,600	66,500	66,500	(D)	(D)	(D)	(D)	(D)	84,600	(D)	(S)
Petroleum refining and extraction	13,29	106,000	120,800	130,400	(D)	(D)	(D)	(D)	(D)	(D)	209,600	200,800
Rubber products	30	61,600	(D)	(D)	(D)	(D)	75,400	(D)	(D)	(D)	(D)	(D)
Stone, clay, and glass products	32	62,900	67,200	73,800	(D)	(D)	(D)	(D)	(D)	118,000	116,000	(D)
Primary metals	33	70,000	79,300	91,000	107,700	118,200	129,900	(D)	(D)	(D)	128,300	118,400
Ferrous metals and products	331-32,3398-99	73,900	83,300	93,300	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(S)
Nonferrous metals and products	333-36	65,600	74,000	87,700	(D)	(D)	(D)	112,000	136,400	138,800	(D)	120,400
Fabricated metal products	34	55,700	62,300	70,500	78,000	(S)	(S)	111,600	112,900	(S)	95,600	(S)
Machinery	35	72,600	78,900	89,900	93,900	103,800	108,400	124,500	142,500	(D)	(D)	(D)
Office, computing, and accounting machines	357	72,300	77,700	92,700	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Other machinery, except electrical	351-56,358-59	73,300	81,400	84,700	(D)	(D)	(D)	(D)	(D)	118,600	111,800	116,600
Electrical equipment	36	76,800	87,200	91,100	95,300	100,000	114,300	121,700	124,900	121,700	123,100	122,900
Radio and TV receiving equipment	365	72,200	80,300	93,400	(D)	(D)	105,300	(D)	(D)	83,100	105,900	106,200
Communication equipment	366	75,500	87,800	92,900	105,500	123,300	135,000	143,000	147,800	139,800	140,900	139,700
Electronic components	367	64,000	72,800	75,600	66,700	69,600	(S)	100,500	114,100	(D)	102,800	(S)
Other electrical equipment	361-64,369	85,100	94,900	98,300	(D)	(D)	(D)	(D)	(D)	(D)	(S)	(S)
Transportation equipment	37					(D)	(D)	(D)	(D)	171,800	184,300	190,200
Motor vehicles and motor vehicles equipment	371	115,600	122,900	135,200	147,400	162,600	184,700	211,400	223,100	(D)	(D)	(D)
Other transportation equipment	373-75,379	67,200	90,900	111,700	(D)	(D)	114,200	(D)	(D)	(S)	(S)	(S)
Aircraft and missiles	372,376	89,400	93,300	101,600	128,400	148,800	143,600	156,000	161,700	153,100	183,800	184,300

See footnotes at end of

Table B-32. Cost per R&D scientist or engineer by industry: selected years (continued)

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Professional and scientific instruments	38	$79,400	$83,800	$89,700	$93,400	(S)	(S)	$116,900	$122,000	(S)	(S)	(S)
Scientific and mechanical measuring instruments	381-82	64,700	(D)	(D)	(D)	(D)	$83,200	(D)	(D)	(D)	(D)	(D)
Optical, surgical, photographic, and other instruments	383-87	89,700	98,400	103,800	(D)	(D)	141,100	(D)	(D)	(D)	(D)	(D)
Other manufacturing industries	27,31,39	57,200	61,900	77,400	(D)	(D)	98,500	(D)	(D)	(S)	(D)	(D)
Nonmanufacturing industries	10-12,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	76,600	83,500	86,400	77,200	$84,800	82,400	84,100	94,600	$91,000	$91,200	(S)
Distribution by size of company [Based on number of employees]												
Less than 500		47,900	53,500	56,300	58,600	62,800	65,700	55,000	(S)	70,600	70,800	(S)
500 to 999								87,200	(S)	103,400	93,400	$93,300
1,000 to 4,999		66,100	70,200	68,600	77,000	84,800	82,800	96,700	97,300	106,400	104,500	103,500
5,000 to 9,999		52,200	56,100	71,400	93,700	82,900	93,400	111,000	119,300	108,400	112,600	127,000
10,000 to 24,999		79,400	84,100	86,200	90,900	98,500	112,900	130,500	124,600	122,300	140,500	128,000
25,000 or more		88,800	96,200	105,800	117,200	128,900	134,200	143,000	155,300	154,300	161,100	173,600

NOTE: The number of full-time-equivalent R&D scientists and engineers used to estimate the cost per R&D scientist or engineer is the arithmetic mean of the numbers of R&D scientists and engineers reported for January in two consecutive years. This number is then divided into the total R&D expenditures of the earlier year, and the ratio is attributed to the earlier year.

(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of 50 percent or more.
(1) Until 1984, tobacco products, SIC 21, was included with "other manufacturing industries."
(2) Not separately available but included in total. See general notes.
(3) Included in the other manufacturing group.

SOURCE: National Science Foundation, SRS

Table B-33. Cost per R&D scientist or engineer(1) by industry and size of company: 1988

Industry	SIC code	Total	Companies with total employment of-- Less than 500	500 to 999	1,000 to 4,999	5,000 to 9,999	10,000 to 24,999	25,000 or more
Total		$138,700	(S)	$93,300	$103,500	$127,000	$128,000	$173,600
Food, kindred, and tobacco products	20,21	(D)	(S)	(S)	107,300	118,700	115,400	(S)
Textiles and apparel	22,23	(D)	(S)	(S)	149,700	(S)	77,100	(D)
Lumber, wood products, and furniture	24,25	(D)	(S)	(S)	131,400	(S)	176,900	(D)
Paper and allied products	26	(D)	(S)	(S)	88,100	69,800	129,200	110,500
Chemicals and allied products	28	146,600	52,100	99,900	137,100	(S)	162,600	(S)
Industrial chemicals	281-82,286	(S)	74,900	92,000	161,200	181,600	238,600	(S)
Drugs and medicines	283	141,500	(S)	157,200	141,600	(D)	156,400	(D)
Other chemicals	284-85,287-89	(S)	52,900	89,400	114,200	(D)	156,500	(D)
Petroleum refining and extraction	13,29	200,800	39,000	(D)	84,200	243,900	175,000	220,300
Rubber products	30	(D)	(S)	(S)	97,900	(S)	96,400	(D)
Stone, clay, and glass products	32	(D)	(S)	(S)	55,700	(S)	138,800	(D)
Primary metals	33	118,400	(S)	(S)	101,900	157,700	128,700	189,600
Ferrous metals and products	331-32,3398-99	(S)	(S)	(S)	131,100	218,000	116,900	(D)
Nonferrous metals and products	333-36	120,400	(S)	(S)	92,900	(D)	(D)	(D)
Fabricated metal products	34	(S)	(S)	(S)	97,600	(S)	113,000	0
Machinery	35	(D)	80,100	98,900	109,800	(S)	99,800	177,200
Office, computing, and accounting machines	357	(D)	(S)	108,700	104,500	(S)	86,400	178,000
Other machinery, except electrical	351-56,358-59	116,600	112,000	84,800	118,500	86,000	116,100	(D)
Electrical equipment	36	122,900	71,400	91,100	97,300	(S)	121,600	140,400
Radio and TV receiving equipment	365	106,200	(S)	(D)	59,400	0	(D)	0
Communication equipment	366	139,700	62,100	(S)	102,400	(D)	(S)	152,300
Electronic components	367	(S)	84,800	93,900	95,800	(S)	116,900	(S)
Other electrical equipment	361-64,369	(S)	(S)	(S)	96,200	(D)	109,400	(D)
Transportation equipment	37	190,200	(S)	117,600	106,900	129,900	168,300	195,200
Motor vehicles and motor vehicles equipment	371	(D)	(D)	(S)	82,300	87,100	169,000	(D)
Other transportation equipment	373-75,379	(S)	(S)	(S)	138,000	(D)	103,900	0
Aircraft and missiles	372,376	184,300	(D)	127,600	117,500	(S)	206,000	184,600

See footnotes at end of

Table B-33. Cost per R&D scientist or engineer(1) by industry and size of company: 1988 (continued)

Industry	SIC code	Total	Companies with total employment of-- Less than 500	500 to 999	1,000 to 4,999	5,000 to 9,999	10,000 to 24,999	25,000 or more
Professional and scientific instruments............	38	(S)	(S)	(S)	98,000	111,600	74,100	(S)
Scientific and mechanical measuring instruments..	381-82	(D)	56,400	74,700	88,700	(D)	(D)	(D)
Optical, surgical, photographic, and other instruments....................................	383-87	(D)	(S)	(S)	109,200	114,000	(D)	(S)
Other manufacturing industries.....................	27,31,39	(D)	(S)	(S)	77,800	(D)	95,800	(D)
Nonmanufacturing industries.........................	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	(S)	(S)	(S)	100,800	105,400	110,700	93,800

(1) See note on table B-32.
(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of 50 percent or more.

SOURCE: National Science Foundation, SRS

Table B-34. Cost per R&D scientist or engineer(1) in companies ranked by size of R&D program: selected years

Companies ranked by size of R&D program [Based on total (company, Federal, and other) funds]	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
First 4......................	$109,400	$121,700	$126,700	$160,200	$182,800	$185,200	$202,000	$225,800	$225,900	$222,600	$226,200
Next 4.......................	103,800	105,700	119,200	138,900	127,600	154,000	167,000	176,200	171,400	196,900	198,200
Next 12......................	83,800	90,500	93,300	107,000	127,500	119,300	127,800	132,500	131,200	141,600	152,000
Next 20......................	80,800	87,600	97,400	101,700	104,200	117,800	121,000	144,000	125,600	146,300	157,000
Next 60......................	74,200	80,100	90,700	96,400	98,000	118,800	130,400	124,100	139,000	128,700	138,900
Next 100.....................	58,700	63,400	71,400	87,900	99,200	96,300	108,900	122,800	146,700	128,600	131,600
Next 200.....................	56,900	61,200	72,800	79,900	86,900	86,400	97,300	94,100	102,500	110,800	115,400
Average of above 400 R&D performing companies........	82,200	88,500	96,600	114,400	118,500	125,400	139,000	144,400	160,400	153,100	159,800

(1) See note on table B-32.

SOURCE: National Science Foundation, SRS

Table B-35. Domestic employment of R&D-performing companies by industry and size of company: 1987-88

[In Thousands]
1987

Industry	SIC code	Total	Companies with total employment of-- Less than 500	500 to 999	1,000 to 4,999	5,000 to 9,999	10,000 to 24,999	25,000 or more
Total		17,633	1,369	612	2,394	1,398	3,402	8,458
Food, kindred, and tobacco products	20,21	1,307	3	29	135	105	241	794
Textiles and apparel	22,23	654	70	(S)	85	52	170	196
Lumber, wood products, and furniture	24,25	254	30	25	80	45	74	0
Paper and allied products	26	559	34	10	80	71	202	162
Chemicals and allied products	28	1,091	104	30	164	88	402	303
Industrial chemicals	281-82,286	448	6	6	52	50	114	220
Drugs and medicines	283	317	17	6	33	(D)	195	(D)
Other chemicals	284-85,287-89	326	81	18	79	(D)	93	(D)
Petroleum refining and extraction	13,29	454	8	4	28	33	69	312
Rubber products	30	491	(D)	33	205	46	97	(D)
Stone, clay, and glass products	32	357	15	23	66	39	107	107
Primary metals	33	481	25	20	109	67	143	117
Ferrous metals and products	331-32,3398-99	268	(D)	9	54	48	60	(D)
Nonferrous metals and products	333-36	213	(D)	11	55	19	83	(D)
Fabricated metal products	34	601	(D)	43	120	62	184	(D)
Machinery	35	1,450	225	78	305	155	172	515
Office, computing, and accounting machines	357	647	29	18	105	38	55	402
Other machinery, except electrical	351-56,358-59	803	196	60	200	117	117	113
Electrical equipment	36	2,010	214	67	256	107	416	950
Radio and TV receiving equipment	365	30	5	(D)	12	0	(D)	0
Communication equipment	366	1,005	42	11	54	37	148	713
Electronic components	367	492	84	24	84	30	(D)	(D)
Other electrical equipment	361-64,369	483	83	(D)	106	40	157	(D)
Transportation equipment	37	2,739	43	31	113	108	280	2,164
Motor vehicles and motor vehicles equipment	371	1,156	(D)	17	53	(D)	104	895
Other transportation equipment	373-75,379	119	(D)	8	29	(D)	53	0
Aircraft and missiles	372,376	1,464	(D)	6	31	(D)	123	1,269

See footnotes at end of

Table B-35. Domestic employment of R&D-performing companies by industry and size of company: 1987-88 (continued)

[In Thousands]
1987

Industry	SIC code	Total	Companies with total employment of-- Less than 500	500 to 999	1,000 to 4,999	5,000 to 9,999	10,000 to 24,999	25,000 or more
Professional and scientific instruments............	38	632	97	34	96	64	60	281
Scientific and mechanical measuring instruments..	381-82	229	55	14	46	27	(D)	(D)
Optical, surgical, photographic, and other instruments....................................	383-87	403	42	20	50	37	(D)	(D)
Other manufacturing industries.....................	27,31,39	353	(D)	31	101	42	126	(D)
Nonmanufacturing industries........................	10-11,14-17,40-42,44-51,53-54,56,60,62-63,72-73,78,806-07,87	4,200	257	72	448	320	659	2,444

[In Thousands]
1988

Industry	SIC code	Total	Companies with total employment of-- 500	999	Less than 4,999	500 to 9,999	1,000 to 24,999	25,000 or more
Total....................................	....							
Food, kindred, and tobacco products	20,21	17,000	(S)	(S)	2,353	1,349	3,081	8,290
Textiles and apparel...............................	22,23							
Lumber, wood products, and furniture...............	24,25	1,283	(S)	(S)	(S)	111	252	772
Paper and allied products..........................	26	(S)	(S)	(S)	(S)	(S)	168	(S)
Chemicals and allied products......................	28	258	(D)	(S)	82	41	56	(D)
		558	(S)	(S)	(S)	73	196	177
Industrial chemicals............................	281-82,286	1,064	(S)	27	179	68	384	303
Drugs and medicines.............................	283							
Other chemicals.................................	284-85,287-89	418	(S)	6	55	39	83	230
		310	(S)	(S)	39	(D)	197	(D)
Petroleum refining and extraction..................	13,29	336	(S)	16	85	(D)	104	(D)
Rubber products....................................	30							
Stone, clay, and glass products....................	32	412	(S)	(S)	(S)	34	69	270
Primary metals.....................................	33	(S)	(D)	(S)	(S)	51	84	(D)
		314	(D)	(S)	(S)	40	98	(D)
Ferrous metals and products.....................	331-32,3398-99	436	(S)	(S)	110	59	99	125
Nonferrous metals and products..................	333-36							
		249	(S)	(S)	49	(D)	(D)	(D)

See footnotes at end of

Table B-35. Domestic employment of R&D-performing companies by industry and size of company: 1987-88 (continued)

[In Thousands]
1988

Industry	SIC code	Total	Less than 500	500 to 999	1,000 to 4,999	5,000 to 9,999	10,000 to 24,999	25,000 or more
			Companies with total employment of--					
Fabricated metal products...........................	34	187	(S)	(S)	61	(D)	(D)	(D)
Machinery...	35							
		575	(S)	(S)	129	62	177	0
Office, computing, and accounting machines.......	357	1,454	(S)	77	285	145	208	520
Other machinery, except electrical...............	351-56,358-59							
		653	28	22	80	58	65	400
Electrical equipment................................	36	801	(S)	55	205	87	143	120
Radio and TV receiving equipment..................	365	1,965	(S)	(S)	241	101	306	1,033
Communication equipment...........................	366							
Electronic components.............................	367	27	(S)	(D)	(S)	0	(D)	0
Other electrical equipment........................	361-64,369	980	41	11	45	32	86	765
		479	(S)	26	72	36	83	173
Transportation equipment............................	37	479	(S)	(D)	114	34	(D)	95
Motor vehicles and motor vehicles equipment......	371	2,574	(S)	(S)	103	121	210	2,068
Other transportation equipment....................	373-75,379							
Aircraft and missiles.............................	372,376	1,076	(D)	(S)	51	(D)	40	858
		120	(D)	(S)	(S)	(D)	57	0
Professional and scientific instruments............	38	1,378	(D)	7	26	(D)	113	1,210
Scientific and mechanical measuring instruments..	381-82	631	(S)	(S)	102	44	66	295
Optical, surgical, photographic, and other instruments....................................	383-87	221	(S)	12	48	(D)	(D)	(D)
Other manufacturing industries......................	27,31,39	410	(S)	(S)	54	(D)	(D)	(D)
Nonmanufacturing industries.........................	10-11,14-17,40-							
	42,44-51,53-54,	325	(D)	(S)	(S)	46	108	(D)
	56,60,62-63,72-	4,046	(S)	(S)	(S)	(S)	603	2,362
	73,78,806-07,87							

(D) Data have been withheld to avoid disclosing operations of individual companies.
(S) Data have been withheld due to imputation of 50 percent or more.

SOURCE: National Science Foundation, SRS

Table B-36. R&D scientists and engineers per 1,000 employees in manufacturing companies by industry and size of company: selected years

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Distribution by industry												
Total		27	27	27	29	33	34	40	43	45	45	47
Food, kindred, and tobacco products(1)	20,21	7	6	5	6	6	6	7	8	7	7	7
Textiles and apparel	22,23	3	3	3	3	4	4	5	5	4	4	4
Lumber, wood products, and furniture	24,25	7	6	6	(S)	(S)	(S)	6	6	5	5	5
Paper and allied products	26	14	14	14	16	14	12	13	13	11	11	11
Chemicals and allied products	28	43	42	42	44	51	54	57	57	70	68	72
Industrial chemicals	281-82,286	38	36	36	37	44	45	41	39	56	52	54
Drugs and medicines	283	65	62	60	66	74	(S)	89	81	98	98	108
Other chemicals	284-85,287-89	27	27	30	33	37	39	51	62	63	61	61
Petroleum refining and extraction	13,29	19	18	17	20	22	22	22	21	19	20	24
Rubber products	30	18	(S)	(S)	25	(S)	(S)	27	26	25	19	17
Stone, clay, and glass products	32	13	13	13	13	15	16	17	20	20	24	27
Primary metals	33	8	7	7	8	10	11	12	12	11	12	13
Ferrous metals and products	331-32,3398-99	6	6	6	6	8	11	11	11	7	9	9
Nonferrous metals and products	333-36	12	12	12	13	13	13	16	16	17	16	18
Fabricated metal products	34	12	12	14	15	(S)	(S)	(S)	(S)	(S)	17	18
Machinery	35	39	38	36	35	48	57	56	60	64	67	68
Office, computing, and accounting machines	357	79	75	72	71	80	88	90	99	107	115	116
Other machinery, except electrical	351-56,358-59	19	19	18	19	26	30	32	29	26	29	30
Electrical equipment	36	41	43	44	48	55	51	49	53	59	65	69
Radio and TV receiving equipment	365	22	29	35	51	(S)	(S)	(S)	23	55	45	49
Communication equipment	366	48	53	55	56	74	61	56	62	68	73	76
Electronic components	367	51	52	55	66	66	(S)	(S)	81	82	86	98
Other electrical equipment	361-64,369	32	32	32	34	(S)	(S)	30	30	26	28	29
Transportation equipment	37							(S)	71	69	68	74
Motor vehicles and motor vehicles equipment	371	26	26	30	30	31	30	27	28	38	42	43
Other transportation equipment	373-75,379	13	11	9	9	12	(S)	(S)	8	23	38	39
Aircraft and missiles	372,376	96	93	92	98	94	102	110	116	99	91	101

See footnotes at end of

Table B-36. R&D scientists and engineers per 1,000 employees in manufacturing companies by industry and size of company: selected years (continued)

Industry and size of company	SIC code	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Distribution by industry												
Professional and scientific instruments	38	42	41	39	46	(S)	(S)	(S)	(S)	(S)	71	71
Scientific and mechanical measuring instruments	381-82	50	(S)	(S)	(S)	(S)	(S)	(S)	(S)	(S)	85	90
Optical, surgical, photographic, and other instruments	383-87	44	45	48	47	(S)	(S)	(S)	70	61	63	60
Other manufacturing industries	27,31,39	9	7	7	7	9	(S)	(S)	(S)	(S)	18	18
Distribution by size of company [Based on number of employees]												
Less than 500		25	24	25	28	30	34	42	50	59	59	56
500 to 999								21	21	23	27	29
1,000 to 4,999		18	18	19	21	22	25	24	26	32	30	32
5,000 to 9,999		17	19	19	18	23	22	19	19	28	29	32
10,000 to 24,999		20	19	20	23	26	26	29	30	33	32	35
25,000 or more		34	34	34	36	43	42	47	49	56	57	60

NOTES: The number of R&D scientists and engineers for 1987 is derived by dividing the arithmetic mean of scientists and engineers employed in January 1987 and January 1988 by the number of employees in all activities in March 1987. Similar procedures were used in earlier years except 1967-69; in those years, data were derived by dividing the number of R&D scientists and engineers for the year by March employment figures.

Nonmanufacturing industries are included in the 1958-83 calculations.

(S) Data have been withheld due to imputation of 50 percent or more.
(1) Until 1984, tobacco products, SIC 21, was included with "other manufacturing industries."
(2) Not separately available but included in total. See general notes.
(3) Data not tabulated at this level prior to the 1972 survey.
(4) Data not tabulated at this level prior to the 1977 survey.
(5) Included in the other electrical equipment group for 1958-63.

SOURCE: National Science Foundation, SRS

Table B-37. R&D funds per employee by size of company: selected years

Size of company [Based on number of employees]	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	Total (company, Federal, and other) R&D funds per employee										
Total	$2,240	$2,453	$2,576	$3,010	$3,719	$4,163	$4,579	$5,148	$5,153	$5,338	$5,848
Less than 500	1,123	1,254	1,418	1,634	1,732	2,186	2,767	3,028	5,414	5,553	5,530
500 to 999							2,158	2,238	3,229	3,121	2,998
1,000 to 4,999	1,066	1,321	1,326	1,596	1,790	2,042	2,480	2,725	3,261	3,395	3,566
5,000 to 9,999	1,143	1,102	1,332	1,668	1,883	2,194	2,505	2,851	2,849	3,210	4,129
10,000 to 24,999	1,407	1,549	1,748	2,045	2,469	2,966	3,385	3,500	3,334	3,668	3,753
25,000 or more	3,045	3,614	3,594	4,193	5,502	5,785	6,184	7,071	6,878	7,035	7,806
	Company and other (except Federal) R&D funds per employee										
Total	$1,487	$1,650	$1,764	$2,059	$2,534	$2,814	$3,095	$3,383	$3,503	$3,562	$3,909
Less than 500	933	956	1,176	1,333	1,381	1,749	2,212	2,407	4,750	4,811	4,841
500 to 999							1,782	1,700	2,997	2,859	2,779
1,000 to 4,999	841	910	1,108	1,311	1,503	1,687	2,096	2,316	2,725	2,799	2,919
5,000 to 9,999	989	987	1,048	1,323	1,551	1,613	2,199	2,409	2,316	2,682	3,420
10,000 to 24,999	1,077	1,237	1,414	1,675	2,025	2,351	2,689	2,769	2,697	2,969	3,155
25,000 or more	1,873	2,271	2,273	2,641	3,436	3,637	3,792	4,208	4,077	4,010	4,479

Note: Averages were derived by dividing total and company R&D funds for a calendar year by employment data for March of that year.

SOURCE: National Science Foundation, SRS

Table B-38. Concentration of total employment in R&D-performing companies ranked by size of R&D program: selected years

[Percent]

Companies	1984	1985	1986	1987	1988
First 4 (1-4)........	8	8	7	7	7
Next 4 (5-8).........	3	4	4	4	4
Next 12 (9-20).......	6	7	5	6	6
Next 20 (21-40)......	9	7	6	6	6
Next 60 (41-100).....	10	11	9	8	9
Next 100 (101-200)...	13	12	7	7	8
Next 200 (201-400)...	15	15	10	9	10
All others...........	36	36	52	53	50

SOURCE: National Science Foundation, SRS

section c

industry-administered federally funded research and development centers

supported by the department of energy

Bettis Atomic Power Laboratory
Westinghouse Electric Corporation
Pittsburgh, Pennsylvania

Hanford Engineering Development Laboratory
Westinghouse-Hanford Corporation
Richland, Washington

Idaho National Engineering Laboratory
EG&G Idaho, Inc.; Exxon Nuclear Idaho Company;
Argonne National Laboratory, West; Westinghouse
Electric Corporation Idaho Falls, Idaho

Knolls Atomic Power Laboratory
General Electric Company
Schenectady, New York

Oak Ridge National Laboratory
Martin Marietta Corporation
Oak Ridge, Tennessee

Sandia National Laboratories
Western Electric Company, Inc.—Sandia Corporation
Albuquerque, New Mexico

Savannah River Laboratory
E.I. duPont de Nemours & Company, Inc.
Aiken, South Carolina

supported by the national institutes of health, department of health and human services

Frederick Cancer Research Facility
Program Resources, Inc.
Frederick, Maryland

section d

survey instruments

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Form MA-121 89

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

OFFICE OF THE
DIRECTOR

Dear Respondent:

The National Science Foundation requests your company's participation in its 1988 Survey of Industrial Research and Development by completing the enclosed questionnaire and returning it to the U.S. Bureau of the Census.

This annual survey is the only source of detailed information on U.S. industry's research and development (R&D) performance, which accounts for approximately 70 percent of total U.S. R&D expenditures. These data are used by industry officials to compare their companies' performance with industry averages, by trade association staff, and by industry consultants. Furthermore, the information represents an essential input into the formulation of legislative and executive branch policy initiatives to strengthen U.S. science and technology.

Your company's participation in the survey is vital to the accuracy and utility of the analysis and interpretation of the data. Even if your records are not formatted to match exactly the survey data elements, your best estimates are requested. Your company's chief official responsible for R&D activities will likely be able to assist in this effort. The survey is based on a performer concept, i.e., all data elements (except items 13 and 14) are keyed to your company's total intramural performance. Please refer to the instructions for further information on definitions used in the survey and feel free to contact the U.S. Department of Commerce, Bureau of the Census, Industry Division, Washington, D.C. 20233 or phone (301) 763-5598 for assistance. Your company's responses are kept confidential by the Census Bureau staff who release survey data only in aggregated form to prevent disclosure of individual firm data.

We appreciate your past and continuing participation in this survey. Requests for information coming from the survey and suggestions for improvements in any aspect of the survey may be addressed to Mr. William L. Stewart, Director, Division of Science Resources Studies, Room L-602, National Science Foundation, Washington, D.C. 20550, or phone (202) 634-4634.

Sincerely,

Erich Bloch
Director

Enclosure

RD-1-L2 (11-7-88)

RD-1-L1
(10-26-88)

UNITED STATES DEPARTMENT OF COMMERCE
Bureau of the Census
Washington, D.C. 20233

OFFICE OF THE DIRECTOR

FROM THE DIRECTOR
BUREAU OF THE CENSUS

The Bureau of the Census conducts the "Survey of Industrial Research and Development" under sponsorship of the National Science Foundation. These measures of research and development expenditures by industry are important in analyzing and forecasting long-term economic growth, investigating productivity determinants, formulating tax policy recommendations, and comparing individual research performance against industry averages.

We are enclosing your report form and file copy for the "Survey of Industrial Research and Development During 1988" (RD-1). To reduce response burden, we alternate between a "long" and a "short" form every other year. We are using the "short" version for 1988.

We also are enclosing an updated instruction manual to assist you in completing the report and a letter from the National Science Foundation describing the importance of the survey results. Please read the instruction manual carefully, since it provides guidelines for reporting. We recognize that you may not maintain book records for particular items. In such cases, please use carefully prepared estimates.

The law (Title 13, United States Code) authorizes this report. Items 1A and 1B and Columns 2 and 4 of Item 4C are part of the basic statistical program of the Bureau of the Census for manufacturing companies, and reporting of these items is mandatory. Response to the remainder of the inquiries is voluntary; however, we need your cooperation to make the results of the survey comprehensive and accurate. By Section 9 of the same law (Title 13), your report to the Census Bureau is confidential. Only sworn Census Bureau employees will see the information reported and will use it only for statistical purposes. The law also provides that copies retained in your files are immune from legal process.

Please return the completed form within 60 days. Please direct requests for copies of the resulting publication or any questions concerning this survey to the Special Projects Branch of our Industry Division on (301) 763-5598. If you need additional time to complete the report or need additional forms, call (812) 288-3331. We appreciate your past cooperation in this important survey and look forward to your continued participation. Thank you.

Sincerely,

John G. Keane

JOHN G. KEANE

Enclosures

FORM **RD-1 (I)**
(9-23-88)

U.S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS

COLLECTING AND COMPILING AGENT FOR
THE NATIONAL SCIENCE FOUNDATION
WASHINGTON, DC 20233

INSTRUCTIONS FOR SURVEY OF INDUSTRIAL RESEARCH AND DEVELOPMENT DURING 1988

Outline of instructions

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- Revision of figures 2
- Coverage — reported unit, period 2

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Section II — RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY IN THE UNITED STATES 2
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  - Cost or Receipts for Research and Development Performed Within the Company by Major Type and Source of Funds 3
- Item 4 — Basic, Applied, and Development 3
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GENERAL

Public reporting burden for this collection of information is estimated to average 2 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information including suggestions for reducing this burden to Herman G. Fleming, National Science Foundation, 1800 G Street, Washington, DC 20550; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503.

Estimates are Acceptable — Reporting on this form may require using informed estimates in answering some of the questions. These estimates are satisfactory if they are sufficient to develop both meaningful totals and, especially, measures of change from year to year. Direct any questions regarding this form to the Bureau of the Census, ATTN: Industry Division, Washington, DC 20233, or call (301) 763–5598.

Companies Reporting in Survey for the First Time — Companies which did not report in the 1987 survey are asked to provide figures for both 1987 and 1988. If the company had no expenditures for research and development, complete only Item 1. Enter "No R&D" in the space for remarks on page 2 of the form, sign, and return the form.

Figures for Earlier Years are Preposted on the Form — If your company reported for 1987, entries from that form have been copied on the present form.

Please describe in the "Remarks" section (page 2 of the form) the reasons for any substantial increases or decreases in the 1988 figures entered on this form when compared to corresponding 1987 figures. Examples of such reasons are new government contracts, acquisitions, and divestitures, revised accounting method, etc. If you acquired or disposed of a unit performing an important amount of research and development during the 2-year period, please identify the unit in "Remarks," and give the total amount of research and development accounted for by such unit.

Revision of Earlier Year Figures — The 1987 figures should be revised if necessary to assure comparability with 1988 data. Please explain in "Remarks" any significant change made in the 1987 figures. If your company did not report for 1987, or if no entries have been entered in the 1987 column, fill in the figures for both years.

Report for Your Entire Company — Research and development (R&D) activities for your entire domestic company should be reported, including all subsidiaries, divisions, etc.

Period Covered by Report — The figures reported should cover the calendar year if possible. Fiscal year data, however, are acceptable for all items except employment, provided your fiscal year ends between September and March. Please report employment figures (Item 1B and Item 3) for the specific period identified in each of the items mentioned.

Geographic Area Covered — The data relate to business firms which operate one or more establishments in one or more of the 50 States or the District of Columbia.

Section I — GENERAL COMPANY DATA

Item 1 — Sales and Employment for Company

Item 1A — Net Sales — Report the net sales and receipts of this company and its subsidiaries to customers outside the company, including sales of products and services to other companies, individuals, U.S. Government agencies, foreign customers; etc. Include transfers to foreign subsidiaries. Exclude domestic intra-company transfers and sales by foreign subsidiaries. The reported figures should represent value f.o.b. plant after discounts and allowances and should exclude freight charges and excise taxes.

Item 1B — Employment— Report the number of persons employed at the company in all activities in the 50 States and the District of Columbia during the pay periods which include March 12 of 1987 and 1988. This figure would be the same as that shown by the company in Item 1 of Treasury Form 941, if the company filed one Form 941 for the entire company.

Section II — RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY IN THE UNITED STATES

Item 2 — RESEARCH AND DEVELOPMENT EXPENDITURES

Definition of Research and Development — Research and development includes basic and applied research in the sciences and in engineering, and design and development of prototype products and processes. For the purposes of this questionnaire, research and development includes activities carried on by persons trained, either formally or by experience, in the physical sciences including related engineering, and the biological sciences including medicine but excluding psychology, if the purpose of such activity is to do one or more of the following things:

1. Pursue a planned search for new knowledge, whether or not the search has reference to a specific application.

2. Apply existing knowledge to problems involved in the creation of a new product or process, including work required to evaluate possible uses.

3. Apply existing knowledge to problems involved in the improvement of a present product or process.

Research and development includes the activities described above whether assigned to separate R&D organizational units of the company or carried on by company laboratories and technical groups not part of an R&D organization. Reporting the R&D activities of such latter groups may require the use of estimates for some of the questions.

Activities to be Excluded From Research and Development — Research and development for purposes of this survey excludes capital expenditures, routine product testing, research in the social sciences or psychology, or other nontechnological activities or technical services.

Please exclude geological and geophysical exploration activities; include, however, the research and development conducted in support of such activities, such as the development or improvement of techniques and processes.

More specifically, exclude from research and development such nontechnological activities as market research, including statistical surveys, market development, economic research, and legal work in connection with patent applications and litigation, and the sale of licensing of patents.

Also exclude from research and development such technical services as: quality and quantity control tests and analyses; troubleshooting in connection with breakdowns in full-scale production, including related analytical work; work required for minor adaptations of a specific product to meet the requirements of a specific customer, including installation and servicing in a customer's plant; engineering and other technical services furnished in accordance with agreements to licensees outside the company; technical plant sanitation control; aid furnished by the R&D organization to manufacturing divisions to enable them to operate in accordance with previously determined formulas, standard practice instructions, or finished product specifications; aid furnished to develop advertising programs and to promote or demonstrate new products or processes, including the cost of material furnished for trial or demonstration; assistance in preparation of speeches and publications for persons not engaged in research and development; and experimental work performed at the request of the patent division to provide information needed during the prosecution of a patent litigation.

Item 3 — Research and Development Scientists and Engineers — Scientists and engineers are defined for this survey as all persons engaged in scientific or engineering work at a level which requires a knowledge of physical or life sciences or engineering or mathematics that is equivalent at least to that acquired through completion of a four-year college course with a major in these fields, regardless of whether they actually hold a college degree in the field.

The figure for R&D scientists and engineers will be obtained primarily from two sources:

1. Records on the number of scientists and engineers assigned to research and development. This source is satisfactory as long as the scientists and engineers of the unit are assigned to research and development on a full-time basis (i.e., no more than 5 percent of their time is spent on nonresearch and development). For example, for company laboratories performing only research and development, report the number of scientists and engineers on the rolls in January. For other units, use source 2.

2. Figures on the proportion of total work time of scientists and engineers that is devoted to research and development. For example, if the engineering department of a manufacturing plant had 60 scientists and engineers in January 1987 and one-fourth of the scientists' and engineers' time during that month was charged to R&D projects, the figure for the number of R&D scientists and engineers included for that unit would be 15.

▶ **Item 4 — Cost INCURRED FOR RESEARCH AND DEVELOPMENT PERFORMED Within the Company by Major Type and Source of Funds** — Include all costs incurred to support research and development including R&D depreciation and overhead but excluding R&D capital expenditures. If you perform research and development for others on contract, report the total charged for the work performed, including profit.

Include in R&D expenditures the full cost of all research and development performed. Do not net your R&D expenditures by the amount of royalties received from either non-company organizations or company units, or the credits received for R&D work charged or "sold" to other units of the reporting company or to outside organizations.

The relevant costs for research and development usually include but are not limited to the elements listed below:

1. Wages, salaries, and related costs; materials and supplies consumed (or purchased, if consumption figures are not available); costs of computer software used in R&D activities; utilities, such as telephone, telex, electricity, water, gas, and fuel; books and periodicals; travel costs and professional dues.

2. Property taxes and other taxes (except income taxes) incurred on account of the R&D organization or the facilities which the R&D organization uses; insurance expense; maintenance and repair, including the maintenance of buildings and grounds; depreciation on buildings, equipment, and vehicles; and rentals, if any facilities are leased.

3. Company overhead. Estimate a fair share of the cost of any functions which support activities. The basis and method of estimating overhead costs will depend upon company practice. Be sure that all companies include an allowance for overhead. Items normally covered in overhead include the following: Personnel; accounting; procurement and inventory, including purchasing, storage, transportation, control, and of materials and supplies, etc.; other services, including legal, public relations; and salaries and related costs of research executives not on the payroll of the R&D organization.

Types of Costs to be Excluded from Research and Development Performed Within the Company — Exclude capital expenditures, royalties paid, patent expense, income taxes, and interest; the portion of company-held R&D contracts which were subcontracted to R&D organizations outside the reporting company; and income from the sale of products manufactured in the R&D organization if these were sold to bonafied customers. Also exclude the cost of research and development performed for the company by noncompany R&D organizations of any kind. (All work that was done for your laboratories and other technical units by noncompany organizations which are **not** R&D organizations—for example, model construction by a non company model shop—is to be included as a **purchase** of equipment, material, or supplies for the company research organization rather than as subcontracted research and development.) Exclude fellowships, grants, gifts to promote research and development or the study of science and engineering.

Methods of Estimating research and Development Expenditures by Type — (Basic, Applied, and Development) — If your company does not keep records that meet or can be allocated to these specific categories, estimate by:

1. Isolating the projects that clearly fall in the development category. If your company fabricates products, such development activity will include the design, construction, and testing of prototypes and models. Some defense contracts typically call for several test models. If your company's research and development frequently involves the development of a "process" as in chemicals and petroleum, such development activity would include operations beyond the bench scale, primarily the design and operations of pilot plants or semiworks.

2. Isolating the organizational units which have R&D activities that can be readily classified, based on the function assigned to the unit. If R&D work is done in production units as well as in various laboratories, it is generally of a development type.

3. Distributing the balance on the basis of a review of individual projects or on the basis of other summaries of the work. Please use the definitions for basis, applied, and development, as given below.

Types of Research

▶ **Item 4A — Basic Research** — Include the cost of research projects which represent original investigation for the advancement of scientific knowledge and which do not have specific immediate commercial objectives, (although they may be in the fields of present or potential interest to the reporting company.)

▶ **Item 4B1 — Applied Research** — Include the cost of research projects which represent investigation directed to discovery of new scientific knowledge and which have specific commercial objectives with respect to either products or processes.

Note that the chief difference between this definition of applied research and the definition of basic research is in terms of the objectives of the reporting company.

▶ **Item 4B2 — Development** — Include the cost of projects which represent technical activity concerned with nonroutine problems encountered in translating research findings or other general scientific knowledge into products or processes. Exclude routine technical services to customers or other items excluded from the definition of total research and development in Item 2 on page 2.

Types of Activity Included in Development — Include the design and operation of pilot plants or semiworks plants as long as the principal purposes are to obtain experience and to compile engineering and other data to be used in such tasks as evaluating hypotheses, writing product formulas, establishing finished product specifications, designing special equipment and structures required by a process, and preparing operating instructions or manuals. Also include the engineering activity required to advance the design of a product or a process to the point where it meets specific functional and economic requirements and can be turned over to manufacturing units. Include the design, construction, and testing of preproduction prototypes and models and "engineering follow through" in the early production phase; the development of designs for special manufacturing equipment and tools; the preparation of reports, drawings, formulas, specifications, standard practice instructions or operating manuals, and other media used to transmit to operating units information obtained from the above activities.

Types of Activity Excluded from Development — Exclude activities such as toolmaking and tool tryout, production of detailed construction drawings and manufacturing blueprints, and preproduction planning.

It is often difficult to decide when development ends and production begins. In general, if the primary objective is to make further improvements on the product or process, then the work comes within the definition of research and development. If, on the other hand, the product or process is substantially "set," and the primary objective is to develop market, do preproduction planning, or get the production process going smoothly, then the work is no longer research and development.

Source of Funds — Federal and Company

▶ **Item 4, Column 2 — Federal** — Include the cost of work done on Federal R&D contracts or subcontracts, and the R&D portions of procurement contracts and subcontracts during the year.

Do not include here, or elsewhere in the report, R&D contracts and the R&D portions of procurement contracts that you subcontracted to other R&D organizations. To do so would cause duplication in the statistical totals derived from these forms, which collect data on work actually performed by each company.

▶ **Item 4, Column 3 — Company and Other** — Include the cost of all company-sponsored research and development performed within the company as well as the research and development your company performed under contract from non-Federal sources. Exclude the research and development that was sponsored by your company but performed outside the company.

▶ **Item 4E — Company and Other Funds, except Federal, Budgeted for the year 1988** — Report the expected or estimated cost of company-sponsored or other non-federally sponsored research and development that will be performed within the company within the 50 States and the District of Columbia.

▶ **Item 5 — Research and Development by Functional Category**

▶ **Item 5A to 5E — Energy Research and Development** — Include all spending for research and development to increase energy resources or capabilities, including the development of energy equipment. Energy research and development can include costs of R&D projects (both product and process) on exploration, extraction, transportation, processing, storage, generation (including conversion), distribution, conservation, etc., of present, new, or improved forms of energy. Record energy R&D spending according to type of energy in Item 5A through 5E.

If R&D spending is for joint or multiple purposes, estimate and report the portion of cost incurred for the energy purpose. In the limited number of cases where the separation of joint (multiple) costs by type of energy cannot be estimated, include the total cost of the R&D project when the **primary** purpose of the project is energy research and development. If the project is not primarily for energy research and development then exclude all of the project cost.

▶ **Item 5C — "Conservation and Utilization"** — Includes R&D activities undertaken to reduce consumption either at the point of energy use or in the transmission, transportation, storage, and conversion of energy. Examples of such are research and development undertaken primarily to reduce fuel consumption in manufacturing, to improve the efficiency of transportation of energy products, or to produce an end product which is more efficient in energy consumption.

▶ **Item 5D — "All Other Energy"** — Includes areas such as wind, waste, hydroelectric, etc. Also include in this category the development of energy equipment which cannot adequately be classified in Items 5A to 5C.

▶ **Item 5F — Pollution Abatement Research and Development** — Include R&D spending for the purpose of reducing or eliminating the emission of pollutants. "Pollution" refers to the emission of pollutants to the outside of a firm's (or household's) property or activities; "abatement" includes prevention, treatment, or recycling. Exclude spending to contribute to environmental aesthetics, to increase equipment durability in corrosive environments, to conserve energy (include as energy research and development in Item 5C) and natural resources, or to increase employee comfort, safety, and health.

If the only purpose of the R&D spending is pollution abatement, include the total expenditures on the R&D project. (Examples are spending on projects to improve or design alternatives to electrostatic precipitators, wet scrubber systems, waste treatment systems, effluent monitoring devices, etc.) If pollution abatement is only one of several purposes, estimate and report only the portion of R&D costs incurred due to the pollution abatement purpose. (Examples of multipurpose projects are those designed to improve production processes or products while simultaneously reducing the emission of pollutants, or pollution abatement projects combined with other purposes such as energy conservation or employee safety and health.)

In the limited number of cases where the separation of joint costs is not feasible, include the total cost of the R&D project when the purpose is primarily (more than 50 percent) for pollution abatement.

If the project is not primarily for pollution abatement, then exclude all of the project cost. Also exclude project costs if expected pollution abatement benefits are incidental. (Incidental benefits are those obtained at no extra cost.)

▶ **Item 6 — Total Company Funds Spent for Research and Development Activities Performed by Foreign Subsidiaries Outside the United States** — Report the amount of research and development financed by the U.S. parent or its foreign subsidiaries and performed by company R&D laboratories, branch plants, divisions, etc., or by other organizations, located outside the United States. This item excludes R&D activities performed by foreign subsidiaries which were financed by foreign governments or other outside organizations.

NOTE — Foreign subsidiaries are those outside the 50 States or the District of Columbia.

DUE DATE: 60 DAYS AFTER RECEIPT OF FORM ☐ OMB No. 3145-0027: Approval Expires June 30, 1990

NOTICE – Your report to the Census Bureau is **confidential** by law (title 13, U.S. Code). It may be seen only by sworn Census employees and may be used only for statistical purposes. The law also provides that copies retained in your files are **immune from legal process.**

Bureau of the Census
1201 East Tenth Street
Jeffersonville, IN 47132

Name of person who supplied 1987 data

Data supplied in items 1A and 1B and in item 4C, columns 2 and 4, for 1988 on this form, will satisfy the mandatory reporting requirement of Census Form MA-121 (title 13, U.S. Code). Your cooperation on the other items is essential to make the results of this survey comprehensive, accurate, and timely.

CENSUS USE ONLY

SURVEY CODE 4001

INDUSTRY CODE

WEIGHT

STATE

ADDRESS

SIC CODE

FORM **RD-1**
(9-20-88)

U.S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS
COLLECTING AND COMPILING AGENT FOR
THE NATIONAL SCIENCE FOUNDATION

SURVEY OF INDUSTRIAL RESEARCH AND DEVELOPMENT DURING 1988

In correspondence pertaining to this report refer to this **CENSUS FILE NUMBER (11 digits)**

PLEASE RETURN THIS COPY
(Please correct any error in name, address, and ZIP Code)

GENERAL INSTRUCTIONS

- Please complete this form and return within 60 days in the envelope provided. Retain the file copy for your records. THIS REPORT SHOULD COVER YOUR ENTIRE COMPANY, INCLUDING ALL SUBSIDIARIES, UNLESS OTHERWISE DESIGNATED AND EXPLAINED IN REMARKS.
- Enter 0 (zero) where appropriate rather than leaving a blank space.
- Reasonably accurate estimates are acceptable.
- Figures for 1987 are those reported by your company last year. THE 1987 FIGURES SHOULD BE REVISED, IF NECESSARY, TO BE COMPARABLE WITH 1988 DATA.
- Explain in "Remarks" on the reverse side any substantial increases or decreases in 1988 figures over 1987 (e.g., new government contracts, acquisitions, mergers, divestitures, etc.)

PLEASE READ ENCLOSED INSTRUCTION MANUAL BEFORE COMPLETING THIS FORM

[illegible]

Item 1 – DOMESTIC SALES, RECEIPTS, AND EMPLOYMENT FOR COMPANY	**1987**	**1988**
A. Domestic net sales and receipts of this company *(Thousands of dollars)*	101	102
B. Total domestic company employment in all activities during the pay period which includes the 12th of March 1987 and 1988	103	104

[illegible]

Item 2 – RESEARCH AND DEVELOPMENT EXPENDITURES

Are research and development expenditures for entire domestic company, including subsidiaries, reported on this form? ☐ YES ☐ NO – *Please explain in remarks or on transmittal letter*

Item 3 – NUMBER OF SCIENTISTS AND ENGINEERS INVOLVED IN RESEARCH AND DEVELOPMENT ACTIVITIES Apportion on a full-time equivalent basis. *(See instruction manual)*	**January 1988**	**January 1989**
TOTAL →	113	114

Item 4 – COSTS INCURRED FOR RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY BY MAJOR TYPE AND SOURCE OF FUNDS

Include R&D depreciation and overhead; exclude R&D capital expenditures. *(See instruction manual)*

		Thousands of dollars			
		1987	**1988**		
		TOTAL research and development (1)	Federal funds (2)	Company and other funds, except Federal (3)	TOTAL *(Sum of columns 2 and 3)* (4)
A. Basic research *If "None," please mark (X)* ☐		201	202	203	204
B. Applied research and development	1. Applied research	211	212	213	214
	2. Development	221	222	223	224
	3. **TOTAL** *(Sum of lines 1 and 2)*	231	232	233	234
C. TOTALS *(Sum of A and B3)* →			242	243	244
D. 1988 TOTALS →			252	253	254
E. Company and other funds, except Federal, budgeted for the year 1989 →				257	

Item 5 – RESEARCH AND DEVELOPMENT BY FUNCTIONAL CATEGORY
Of the total reported in item 4C, columns 2 and 4, report the following functional categories.

ENERGY RESEARCH AND DEVELOPMENT Include the project cost or portion of project cost incurred for the purpose of increasing energy resources or capabilities. Include cost by type of energy.	*Thousands of dollars*					
	1987		**1988**		**1989**	
	Federal funds	**Total funds**	Federal funds	**Total funds**	Projected Federal funds	**Projected total funds**
A. Total nuclear	801	802	803	804	805	806
B. Total fossil fuels	815	816	817	818	819	820
C. Total geothermal, solar, conservation and utilization	853	854	855	856	857	858
D. All other energy	871	872	873	874	875	876
E. Total of A through D →	877	878	879	880	881	882

POLLUTION ABATEMENT RESEARCH AND DEVELOPMENT Include the project cost or portion of the project cost incurred for the purpose of designing pollution abatement products or product characteristics or of designing pollution abatement features into processes.	*Thousands of dollars*					
	1987		**1988**		**1989**	
	Federal funds	**Total funds**	Federal funds	**Total funds**	Projected Federal funds	**Projected total funds**
F. Total →	929	930	931	932	933	934

SECTION III – RESEARCH AND DEVELOPMENT PERFORMED OUTSIDE THE DOMESTIC COMPANY WITH COMPANY FUNDS [illegible]

Item 6 – TOTAL COMPANY FUNDS SPENT FOR RESEARCH AND DEVELOPMENT ACTIVITIES PERFORMED BY FOREIGN SUBSIDIARIES OR BY OTHER ORGANIZATIONS OUTSIDE THE UNITED STATES	*Thousands of dollars*	
	1987	**1988**
	972	973

CONTINUE ON REVERSE SIDE

Item 7 – STATUS OF THIS COMPANY ON DECEMBER 31, 1988

A. Was the company listed in the address label owned or controlled by another company on December 31, 1988?

☐ Yes – *Complete item 7B*
☐ No – *Skip to item 8*

B. New owner information

Name 985	Date acquired 986

Address *(Number and street)*
987

City 988	State 989	ZIP Code 990

REMARKS
991

Item 8 – CERTIFICATION – This report is substantially accurate and has been prepared in accordance with instructions.

Key	Name of person to contact regarding this report – *Print or type*	Mo.	Day	Year
992				

Key	Telephone			Signature of authorized official
	Area code	Number	Extension	
993				

FORM RD-1 (9-20-88)

DUE DATE: 15 DAYS AFTER RECEIPT OF FORM

OMB No. 3145-0027: Approval Expires 09/30/90

FORM **MA-121**
(9-21-88)

U.S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS

COMPANY SUMMARY OF RESEARCH AND DEVELOPMENT

1988

NOTICE — Response to this inquiry **is required by law (title 13, U.S. Code**, sections 131, 182, 224, and 225). By section 9 of the same law, your report to the Census Bureau is **confidential**. It may be seen only by sworn Census employees and may be used only for statistical purposes. The law also provides that copies retained in your files are **immune from legal process.**

RETURN TO

Bureau of the Census
1201 East Tenth Street
Jeffersonville,IN 47132

(Please correct any error in name, address, and ZIP Code)

Please complete and return this form in the return envelope not later than 15 days after you receive it. Companies with no research and development expenditures should so state in the "Remarks" section, fill in items 1a and 1b, sign, and return the form.

PLEASE RETURN THIS COPY

PLEASE READ INSTRUCTIONS ON REVERSE SIDE BEFORE COMPLETING YOUR REPORT

Item 1 — SALES AND EMPLOYMENT FOR COMPANY

	1988 *(Thousands of dollars)*
a. Domestic net sales and receipts of this company	102
	Number
b. Total domestic company employment in all activities during the pay period which includes the 12th of March 1988	104

	1988 *(Thousands of dollars)*		
	Federal funds (2)	Company and other funds, except Federal (3)	**TOTAL** *(Sum of columns 2 agd 3)* (4)
Item 2 — COST OR RECEIPTS FOR RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY DURING 1988	242	243	244

Remarks
991

Item 3 — STATUS OF THIS COMPANY ON DECEMBER 31, 1988

a. Was the company listed in item 1 owned or controlled by another company on December 31, 1988? ☐ Yes — *Complete item 3B* ☐ No

b. New owner information

Name 985		Date acquired 986
Address *(Number and street)* 987		
City 988	State 989	ZIP Code 990

Please continue on reverse ⟶

GENERAL INSTRUCTIONS

Public reporting burden for this collection of information is estimated to average 1 hour per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information including suggestions for reducing this burden to Herman G. Fleming, National Science Foundation, 1800 G Street, Washington, DC 20550; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503.

A report should be filed by each company receiving a copy of this form. If your company does not conduct research and development, so state in remarks, fill in items 1a and 1b, sign, and return the form. If you have questions regarding reporting problems on this form, please write to the Bureau of the Census, Industry Division, Washington, DC 20233.

Report for your entire company — Research and development activities for your entire domestic company should be reported.

Period covered by report — The cost figure reported should cover the calendar year if at all possible. However, fiscal year data are acceptable, provided your fiscal year ends between September and March.

DEFINITION OF RESEARCH AND DEVELOPMENT

Research-development includes basic and applied research in the sciences (including medicine) and in engineering, and design and development of prototypes, products, and processes. It does not include quality control, routine product testing, market research, sales promotion, sales service, research in the social sciences or psychology, or other nontechnological activities or technical services.

SPECIFIC INSTRUCTIONS BY ITEM

Item 1 — Sales and Employment for Company. In item 1a, report the net billings of this company and its subsidiaries to customers outside the company. (Exclude domestic intra-company transfers and sales by foreign subsidiaries. Include the transfers to such foreign subsidiaries, however.) In item 1b, report the number of persons employed by the company in all activities in the 50 States and the District of Columbia during the pay period which includes the 12th of March 1987. This figure would be the same as that shown by the company in item 1 of Treasury Form 941, if the company filed one form 941 for the entire company.

Item 2 — Show all costs incurred within the company for wages and salaries, direct material costs, services and supporting costs, and an appropriate share of company overhead to conduct research and development activities.

Under Federal funds, include research and development in procurement as well as research and development contracts and research and development subcontracts. Exclude research and development subcontracted to others.

Remarks (Continued)
991

Name of person to contact regarding this report 992	Address *(Number and street, city, State, ZIP Code)*	Telephone *(Area code, number, extension)* 993

CERTIFICATION — This report is substantially accurate and has been prepared in accordance with instructions

Name of company	Address *(Number and street, city, State, ZIP Code)*	
Signature of authorized official	Title	Date

FORM MA-121 (9-21-88)

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

RETURN THIS COVER SHEET TO ROOM 233. IF YOU DO NOT WISH TO RECEIVE THIS MATERIAL ☐ , OR IF CHANGE OF ADDRESS IS NEEDED ☐ , INDICATE CHANGE. INCLUDING ZIP CODE ON THE LABEL. (DO NOT REMOVE LABEL).